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THE HENRI FARMAN HYDRO-AEROPLANE AT THE DEAUVILLE MEETING IN FRANCE.—[See page 218.]

The Distribution of Heat in the Operation of Steam Boilers*

A Study of the Controllable Losses May Aid in Increasing Efficiency

By Perry Barker

In the process of combustion of coal in boiler furnaces a comparatively large percentage of the heat in the fuel is not usefully employed for the generation of steam. The extent of the losses which ultimately affect the boiler efficiency is governed by (*a*) the design and physical condition of the plant, (*b*) the personal element in the operation of the boilers and furnaces, (*c*) the character and adaptability of the fuel for the plant in question, and (*d*) the rate of steam generation of capacity at which the boiler is operated. The efficiency with which fuel is burned is controlled by these factors, and excessive losses may be due to one or a combination of the contributing causes.

In accordance with the recent recommendations of the Power Tests Committee of the American Society of Mechanical Engineers, a balance accounting for the distribution of heat in a pound of dry coal fired consists of the following items:

I. Heat absorbed by the boiler.

II. Loss due to evaporating and superheating moisture in coal.

III. Loss due to evaporating and superheating moisture formed by the combustion of hydrogen and distillation of oxygen-hydrogen compounds in the coal.

IV. Loss due to heat carried away by dry flue gases leaving the boiler.

V. Loss due to heat escaping through the formation of carbon monoxide (CO).

VI. Loss due to combustible removed from ash pits and from grates during cleaning.

VII. Loss due to superheating moisture in the air used for combustion.

VIII. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for.

Of the items enumerated above, (IV), (V) and (VI) generally constitute about 75 per cent of the total heat which is lost in the operation of steam boilers and are the variable factors which have a direct effect on the percentage of heat imparted to the water in the generation of steam. In presenting certain data on these losses, illustrations of the origin, extent and methods which have been employed for their reduction, are submitted.

The loss which is generally the largest and in the majority of cases most easily reduced, is the heat carried away by the dry flue gases escaping from the boiler. Under this heading are included the sensible heat in the carbon dioxide and carbon monoxide, if any, formed by the combustion of the carbon in the fuel and the heat in the air in excess of that theoretically required leaving the boiler at the temperature of the escaping gases.

The principal causes of this loss are as follows:

(*a*) Improper methods of firing, which allow large quantities of air to enter the furnace either through the grates or fire doors.

(*b*) Condition of boiler settings. If the settings are cracked and the iron work is badly warped, a large amount of air is drawn through any openings, thereby reducing the draft available at the grate, diluting and cooling the gases as they pass over the heating surface.

(*c*) Poor quality of coal. Coals which contain a high percentage of ash or have a tendency to clinker cause an uneven distribution of the air through the fuel bed. When such a condition exists, large volumes of excess air enter the furnace and carry away heat in the flue gases. If the fuel is particularly fine it will pack on the grate and produce an effect similar to that noted above.

This loss depends upon the weight of gases per pound of carbon burned together with the temperature at which these gases leave the boiler. The data which are required for this computation are the temperature of the flue gases, temperature of the boiler room, composition of the flue gases, the heating value of the coal and the carbon content of the fuel and ash pit refuse.

Several tests conducted in a plant in which the loss of heat in the flue gases was originally high are submitted in Table I. The plant in question consisted of hand-fired horizontal return tubular boilers equipped with plain grates upon which Pennsylvania semi-bituminous coal, containing about 9.00 per cent of ash and 22.00 per cent of volatile matter was burned. The fires in this plant were carried at a thickness not exceeding 7 inches and were uneven, thereby permitting a very large air excess. The thickness of the fire was increased and the methods of firing were altered which resulted in a reduction of the loss of heat due to the enormous air excess from 36 to 12 per cent, with a resultant increase of about 20 per cent in the boiler efficiency. These tests afford conclusive evidence that the air excess maintained throughout the latter tests was somewhat lower than could be recommended for regular operation, as it will be observed that considerable carbon monoxide was formed under the existing conditions of air supply.

Table I—Plant Showing Excessive Loss Due to Heat Carried Away by Dry Flue Gases Leaving the Boiler

	Original conditions	Tests to effect improvement in efficiency	
1. Loss due to heat carried away by the dry flue gases	35.9	10.0	12.4
2. Loss due to evaporating and superheating moisture in coal and moisture formed by the combustion of hydrogen and distillation of oxyhydrogen compounds	2.7	2.7	2.8
3. Loss due to heat escaping through the formation of carbon monoxide	0.0	0.4	1.6
4. Loss due to combustible removed from the ash pits and from the grate during cleaning	3.2	7.6	4.5
Total determined losses	41.8	20.7	21.3
5. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for (assumed constant for all tests)	8.9	8.9	8.9
6. Approximate percentage of heat absorbed by the boiler or boiler efficiency (by difference)	49.3	70.4	69.8
Total	100.0	100.0	100.0

The loss of heat due to incomplete combustion of carbon to carbon monoxide is usually an important factor in studying and perfecting the process of combustion. Carbon monoxide occurs in flue gases generally accompanied by tar vapors or particles of solid carbon in the form of smoke, together with small percentages of unburned hydrogen and hydrocarbon gases. The formation of carbon monoxide is due to the following causes:

(*a*) Furnaces of poor design.

(*b*) Improper methods of firing.

(*c*) The character of the fuel, particularly with reference to the equipment in which it is burned.

While the presence of carbon monoxide (CO) shows that some heat is lost through incomplete combustion, a small percentage of this constituent generally indicates that the air excess is reduced as low as practicable. A small amount of smoke, as evidence of the presence of carbon monoxide, is a more convincing indication of economical furnace operation than a smokeless stack which may be emiting several hundred per cent of excess air.

The extent of this loss is dependent upon the percentage of carbon monoxide (CO) and carbon dioxide (CO_2) as determined by the flue gas analysis, the heating value of the coal and the percentage of carbon in the coal fired and in the ash pit refuse.

The results of several tests in a plant where loss due to unburned gases, as indicated by the presence of carbon monoxide (CO), was particularly high, are shown in Table II. The boiler equipment consisted of hand-fired vertical tubular boilers having shaking grates. Coal from the Georges Creek field, containing approximately 18.00 per cent of volatile matter, was burned. The high loss due to incomplete combustion was not attributed to the character of the coal although it had been proved that the furnace space in the boilers was not sufficient to burn coals containing higher percentages of volatile matter without the production of excessive amounts of smoke, indicating a large loss due to incomplete combustion. Aside from the question of furnace design, the primary cause of the high percentages of carbon monoxide (CO) was the thickness of the fires. By reducing the thickness from 30 inches to 12 inches and changing the manner in which the coal was fired, the loss due to this factor was reduced from 14 to 1 per cent, with a corresponding increase in boiler efficiency.

In the operation of a boiler plant, a certain percentage of the fuel which is fed to the furnace drops through the grate and is removed from the ash pit. An additional quantity of unburned coal is drawn from the grates in hand-fired plants when the fires are cleaned. The amount of fuel lost in this manner depends on:

(*a*) The character of the coal.

(*b*) The condition of the equipment.

(*c*) The methods employed in handling the fires.

If the coal is fine or non-caking and the grates contain large air spaces, excessive amounts of fuel drop into the ash pits. Certain coals clinker badly under some conditions of operation and, therefore, during the removal of this clinker excessive amounts of unburned coal are drawn from the fires. Another cause of this loss is the frequent barring or raking of the fires when a fine or non-caking coal is used.

Table II—Plant Showing Excessive Loss Due to Heat Escaping through the Formation of Carbon Monoxide (CO)

	Original conditions	Tests to effect improvement in efficiency	
1. Loss due to heat escaping through the formation of carbon monoxide (CO)	15.3	1.1	2.1
2. Loss due to evaporating and superheating moisture in coal and moisture formed by the combustion of hydrogen and distillation of oxyhydrogen compounds	4.1	3.8	4.2
3. Loss due to heat carried away by the dry flue gases	9.7	15.1	10.7
4. Loss due to combustible removed from the ash pits and from the grate during cleaning	3.2	3.5	3.3
Total determined losses	32.3	23.5	20.3
5. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for (assumed constant for all tests)	11.2	11.2	11.2
6. Approximate percentage of heat absorbed by the boiler or boiler efficiency (by difference)	56.5	65.3	68.5
Total	100.0	100.0	100.0

The ash pit loss, which also includes the combustible removed during cleaning, is determined from the weight of this material, the percentage of combustible which it contains together with the weight of the dry coal fired. For the purpose of this computation the heating value of the combustible is taken as 14,600 B. t. u. per pound. In special cases where complete boiler tests are not made and the weights of coal and ash pit refuse are not obtained, the percentage of the heat in the fuel removed with the ash pit refuse and cleanings can be computed from the analysis of this material and the determination of the percentage of ash in the coal as fired. In calculating this item by the latter method the assumption must be made that the percentage of ash obtained by the proximate analysis of the fuel represents the inert matter in the ash and refuse removed from the ash pits and the furnaces; that is, no account is taken of the ash which is carried off the grates and deposited in the combustion chamber, upon the water heating surface or lost up the stack. A series of tests which indicate the extent to which this loss can be reduced are submitted in Table III. This plant was equipped with inclined grate stokers upon which Pittsburgh slack coal was burned. The excessive rate at which the fuel was burned in order to maintain the required capacity caused deterioration of the grates, which allowed large amounts of unburned coal to fall into the ash pits. By careful attention to grate repairs and methods of operating the stokers the boiler efficiency was increased approximately 10 per cent.

Table III—Plant Showing Excessive Loss Due to Combustible Removed from Ash Pits and from Grates during Cleaning

	Original conditions	Tests to effect improvement in efficiency	
1. Loss due to combustible removed from the ash pits and from the grate during cleaning	13.1	9.1	7.9
2. Loss due to evaporating and superheating moisture in coal and moisture formed by the combustion of hydrogen and distillation of oxyhydrogen compounds	3.2	3.3	3.4
3. Loss due to heat carried away by the dry flue gases	22.8	19.1	18.2
4. Loss due to heat escaping through the formation of carbon monoxide	0.0	0.0	0.0
Total determined losses	39.1	31.5	29.5
5. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for (assumed constant for all tests)	7.5	7.5	7.5
6. Approximate percentage of heat absorbed by the boiler or boiler efficiency (by difference)	53.4	61.0	63.0
Total	100.0	100.0	100.0

The percentage of hydrogen in various coals is not an indication of their relative value when burned for the generation of steam. The essential feature in determining the effect of this constituent in the process of combustion is the form in which it is available in the furnace. Hydrogen, which is driven off in the uncombined state and burned by mixing with the oxygen from the air supply, is a valuable factor in the process of combustion as it develops about four times the heat generated by an equal percentage of carbon. However, a certain percentage of the hydrogen in coal is

* Presented at the Boston meeting of the American Institute of Chemical Engineers, June 25th to 28th, 1913, and published in *The Journal of Industrial and Engineering Chemistry*.

distilled from the bituminous matter in the form of tar vapor and water. The nature of these compounds has been ascertained when coal is subjected to destructive distillation, as in the manufacture of illuminating gas, but the transformation through which this portion of the hydrogen passes in the boiler furnace is as yet undetermined. For the purpose of this discussion the theory of the code of the American Society of Mechanical Engineers for conducting steam boiler trials, for the loss due to hydrogen, is accepted. This theory assumes that all hydrogen contained in the fuel, together with an equivalent amount of oxygen in the form of water, is raised from boiler room temperature, evaporated in the furnace, and is eventually superheated to the temperature of the escaping gases. The amount of heat lost in this manner depends upon the composition of the fuel, the temperature of the boiler room and the temperatures of the escaping gases. In addition to the loss due to evaporating and superheating the moisture formed by the combustion of hydrogen and by the distillation of oxyhydrogen compounds, a small loss is incurred by subjecting the moisture in the fuel and in the air used for combustion to these processes.

Increasing interest in the economical operation of boiler plants has resulted in marked improvement in efficiency in the majority of the plants where this matter has been given careful attention. An illustration of the distribution of heat in a boiler plant which was operating with high efficiency before tests were made for contemplated improvement is shown in Table IV. This plant consisted of large units of Climax water tube boilers equipped with circular grates which were fired through a number of doors. It will be noted from the tabulation that considerable loss due to the formation of carbon monoxide (CO) occurred, but this waste is more than counterbalanced by the particularly small percentage of combustible removed from the ash pits and furnaces. The amount of combustible in this material averaged about 12 to 15 per cent, representing a fuel loss of from 0.5 to 1.0 per cent. Although the operating conditions in this plant were excellent, still greater care in the methods of firing effected an increase in boiler efficiency.

Table IV—Plant Operating with High Efficiency

	Original conditions	Tests to effect improvement in efficiency	
1. Loss due to evaporating and superheating moisture in coal and moisture formed by the combustion of hydrogen and distillation of oxyhydrogen compounds	4.0	3.8	3.8
2. Loss due to heat carried away by the dry flue gases	14.4	10.1	11.8
3. Loss due to heat escaping through the formation of carbon monoxide	0 9	1.3	0.4
4. Loss due to combustible removed from the ash pits and from the grate during cleaning	0.6	0.8	0.9
Total determined losses	19.9	16.0	16.9
5. Loss due to unconsumed hydrogen and hydrocarbons, to radiation and unaccounted for (assumed constant for all tests)	8.0	8.0	8.0
6. Approximate percentage of heat absorbed by the boiler or boiler efficiency (by difference)	72.1	76.0	75.1
Total	100.0	100.0	100.0

The object of this article has been to indicate in a general way the problems which are encountered in determining the distribution of heat in the operation of a boiler plant. A study of the controllable losses, giving particular attention to the personal element, design and character of the equipment and quality of the fuel by the application of the principles of engineering and chemistry, can undoubtedly reduce them and effect a marked increase in efficiency.

The Frozen Meat Industry of New Zealand*

By A. M. Wright

No industry in New Zealand owes more to science than does that associated with frozen meat, and probably no science has contributed more to the success of this industry than chemistry. In every department of this important business, scientific control is exercised, not merely to maintain a high standard of quality for the products and by-products, but also to establish strict economy in manufacture, upon which the success of this trade depends. When we consider that for the year 1912 the Dominion exported 5,656,164 carcasses of mutton and lamb, it will be realized that the economic utilization of the by-products therefrom is a matter of no small concern; indeed, it may be fairly claimed for this industry that the meat itself is the by-product, to such magnitude and importance have the former waste products attained.

In the earlier days of this business, the pelts and the largest portion of the viscera were buried, and in many works even the blood was allowed to run to waste; gradually, however, chemistry has come into her own, and while in many instances waste occurs, yet in the larger works utilization of the various tissues and organs is carried out and rigidly controlled. A consideration of the methods of utilization and of the problems still awaiting solution may be of interest.

FROZEN MEATS.

The influence of cold storage upon meats has been studied fully by Richardson and Scherubel[1] and Emmett and Grindley[2] on beef, and by Wright[3] on lamb and mutton. These workers have shown that while certain changes occur under commercial conditions, yet these changes, which are probably due to enzyme action, do not affect the nutritive values, and are not bacterial. In addition to the dressed carcasses of mutton and lamb, certain organs and glands are packed and frozen for export, namely, kidneys and sweetbreads, the latter being the thymus gland. Little or no trouble has been found in keeping the sweetbread in cold storage for lengthy periods, but the kidney has been a source of frequent loss, the reason for which has not been definitely determined, but is probably due to the fact that this product is not placed soon enough in cold storage, and that incipient decomposition has ensued prior to freezing; in addition, the surfaces of the kidneys, on the outside of the boxes, have a darkened appearance and are blistered; the cause of this has not yet been discovered, but experiments in this direction are now being conducted.

OLEOMARGARINE.

The abdominal fat and portion of the back and kidney fat are used in the manufacture of oleomargarine, which follows American practice. At certain seasons of the year a flavor sometimes develops in this material some days or even weeks after manufacture; the odor and taste are suggestive of turnips; it was found almost invariably to be associated with the product containing small amounts of animal tissue in suspension, when the fat was melted. Heating the fat to 160 deg. F. and rapidly cooling it thereafter, prevented the development of the flavor and odor; the trouble was probably due to an enzyme reacting upon the albuminous material present; more careful rendering to eliminate the trace of animal tissue however remedies the trouble, which is not evident immediately after manufacture.

* Reproduced from the *Journal of Industrial and Engineering Chemistry*.

[1] *J. Am. Chem. Soc.*, 30, 1515; *J. of Ind. and Eng. Chem.*, 1, p. 95.

[2] *J. of Ind. and Eng. Chem.*, 1, p. 413,

[3] *J. Soc. Chem. Ind.*, 31, p. 965.

CASINGS.

The intestines after the removal of their contents are cleaned and packed with salt for export. Occasionally trouble will arise through the development of a reddish coloration due to bacteria, usually *B. prodigiosus;* this trouble is remedied by better care being exercised in the salting of the product. Sometimes the casings after being cleaned are frozen and shipped to Britain in this state.

TANKAGE AND BLOOD.

The heads, lungs, livers, paunches, and part of the intestines together with the animals condemned as diseased are rendered in large vats for the recovery of fat; the residue, after the removal of the tallow, is pressed and dried for fertilizer. One of the problems met with in the treatment of this material is the amount of fat retained, the dried tankage containing up to 20 per cent of fat. By careful tanking and pressing not more than 15 per cent of fat need be retained, but even this amount presents a waste of no inconsiderable importance; extraction of the dried material with solvents under commercial conditions has been found to reduce the grease to 2 per cent, but up to the present no effort is being made to recover this valuable material in the above manner. The liquor from the vats after the rendering of the offal contains relatively large amounts of soluble nitrogenous material, equal to upward of 25 per cent of the tankage produced. So far, in this country, no provision has been made for the recovery of this asset, although experiments have shown that it is a profitable undertaking. One firm, however, is installing an evaporating plant to deal with this material. The blood cooked in vats and the coagulated material, after the removal of the surplus water by wringing, is dried and mixed with the tankage. The trotter bones, after tanking, and the removal of the oil, are dried and crushed for bonedust. The fats, after recovery from the tanks, are refined and casked for export, no attempt being made to bleach the material, some of which is dark in color. The tankage and blood are used in the manufacture of artificial fertilizers in conjunction with superphosphates, potash salts, and mineral phosphate, each factory using formulæ which experience has shown to give most satisfactory results for the crops and soils whereon they are applied.

WOOL AND PELTS.

The skins are washed in running water to remove adhering dirt and blood. Thereafter they are placed in hydro extractors to eliminate the surplus water and are then painted on the flesh side with a suitable mixture of sodium sulfide and lime; this loosens the wool after a few hours, depending upon the temperature. Then the wool is easily pulled off and, after classification, it is dried mechanically and packed for export. The pelts, after the removal of the wool, are washed and limed, then scudded and fleshed; after deliming in fermented bran infusion or in dilute lactic and acetic acids, they are pickled in a concentrated salt solution to which sulfuric acid has been added. Trouble has arisen in connection with the cured pelts, through the development of purple stains, and while doubtless some of these were due to iron, yet in the majority of cases the cause has been definitely traced to certain micro-organisms capable of growing on pelts containing 8 to 9 per cent of salt and 0.3 per cent free sulfuric acid; experiment has demonstrated that properly cured pelts containing 12 to 13 per cent of salt and 0.5 to 0.6 per cent of free acid will withstand damage from the micro-organisms, *B. prodigiosus*, which do cause purple stain in pelts not sufficiently cured.

PRESERVED MEATS.

The tongues of the slaughtered animals form the chief material useful in canning, although to meet demands, considerable quantities of mutton and beef are also canned. The methods of preparation and canning follow on the whole American practice. In the curing of the meats it was found that a pure salt of 99.9 per cent purity was removing more of the soluble protein and meat bases than a salt of 97 per cent purity containing small amounts of magnesium and calcium salts, leaving the cured meats somewhat flavorless; it was found necessary to discontinue the use of the former salt on account of its purity; the influence of the impurities present in some curing salts upon the soluble matter of meat is at present the subject of investigation. The Pure Food regulations of New Zealand prohibit the use of more than 0.2 per cent of saltpeter in preserved meats.

MEAT EXTRACT.

In the manufacture of this product, the material chiefly used in New Zealand is mutton; hearts and diaphragms are principally used, the material being coarsely minced and extracted in hot water, the resulting liquor, after filtration, being concentrated by open pan evaporation. It has been demonstrated that prolonged heating, such as that given in the open pan evaporation, is productive of the formation of certain bitter substances which give a "burned" flavor to the extract. These are probably peptone-like substances of which up to 12 per cent may be present in an extract "burned" flavor. In the preparation of an extract by rapid vacuum evaporation from a similar liquor there is found but 0.3 per cent of peptone-like substance and the "burned" flavor is absent.

CHEMICAL CONTROL.

Tankage is examined for moisture, nitrogen, fat and tricalcic phosphate; blood for moisture, and nitrogen, moisture above 10 per cent being considered excessive and fat above 15 per cent indicative of faulty rendering; the amount of bone present in the tankage determines largely the relative proportions of nitrogen and tricalcic phosphate. Mixed fertilizers are examined to insure that they are up to the registered minimum guarantee.

Tallows are examined for titer, acidity, moisture, and ether-insoluble matter. Determinations of moisture, fat, and dirt are made on the wool samples. In oleomargarine the moisture, acidity, and foreign matter are determined as well as a note made of the "seeding," the odor, and the taste.

Meat extract is examined for moisture, salt, total nitrogen, acidity, fat, insoluble and coagulable proteids, proteoses, peptones, meat bases, and ammoniacal nitrogen. In order to insure compliance with the pure food regulations, the amounts of potassium nitrate in preserved meats are controlled from the laboratory by frequent examinations. Pelts are examined for salt and free acid.

The water used in the preparation of the various foods is examined bacteriologically as well as chemically; the wrappers used for covering the frozen meats are examined for weighting matters, and soluble organic matter (chiefly starch) as well as being subject to test as a medium for the growth of micro-organisms. The various stores used in connection with the manufacture and preparation of the products are purchased subject to control in the laboratory.

During the "off" season research work dealing with the problems met with in this industry is carried out.

Fig. 1.—Machine tools equipped with individual electric drive in a workshop.

Prevention of Accidents in Factories*

Good Work Done by a German Firm

Fig. 2.—Protecting goggles and screen for chisel work.

Fig. 3.—Protecting headgear for female workers, shown in wrong and correct position.

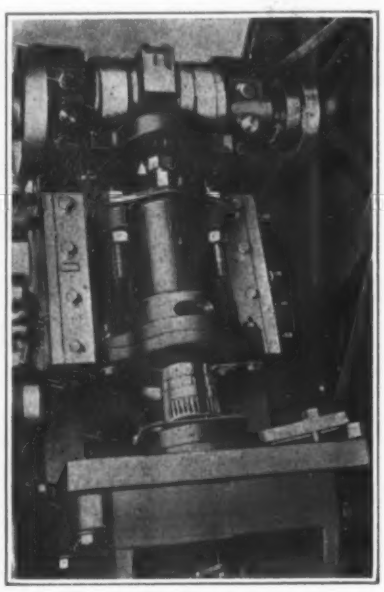


Fig. 4.—Protecting device on an eccentric press.

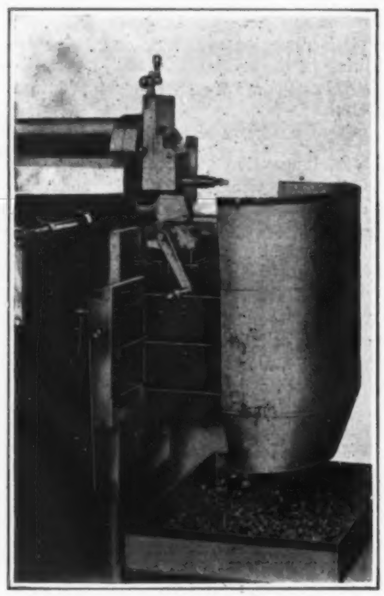


Fig. 5.—Shaping machine with shaving catcher.

Fig. 6.—Centrifugal with a single cover and slide rod protection.

The precautions taken for the protection of workmen against accidents have made great progress in Germany during the last few years, great assistance being rendered in this direction by the passing of the workmen's accident insurance act of July 6th, 1884, and the extension of the act in May 28th, 1885. A science of accident prevention thus arose, the whole efforts of which are devoted to avoiding the dangers in factory work.

Modern industrial undertakings such as the AEG make every possible endeavor to protect their workmen from injury by adopting all the means available, and rightly go far beyond the prescribed limits of the act in the provision of safety and protective devices. The principal protective devices employed in their factories are briefly described herewith.

It is pleasing to note the entire absence of all transmission gear in these factories. Each machine is equipped with an individual electric drive (Fig. 1). A great number of accidents are prevented by this means alone. The busy railway traffic which is carried on all over the very extensive grounds of the factories, (Fig 8) is controlled by strict regulations. The small and much used transport trolleys (Fig. 10) are fitted with iron frames which enclose the wheels directly above the rails, in order to protect the feet of the workmen from injury.

* Reproduced from the *AEG Journal*.

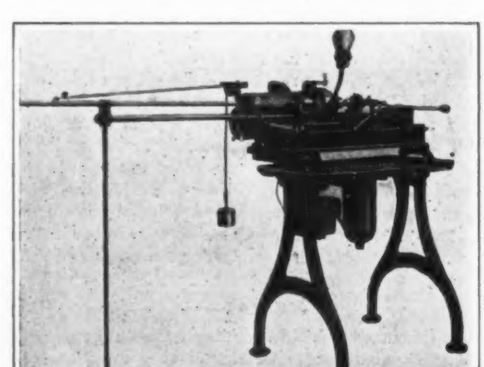


Fig. 7.—Protecting tube covering the rod of rotating material on a turret lathe.

At the presses and stamping machines (Fig. 4) every precaution is taken to prevent the operator from placing his hand under the press while the stamping or pressing process is going on. This safety apparatus includes levers for starting the machines, which occupy both hands, protecting sleeves which can be pushed together, and other devices. Protecting gratings which catch the shavings are mounted on the shaping machines (Fig. 5) to prevent accidents which might otherwise occur owing to the shavings flying off when working brittle material. The welding machine operators are protected against injury from particles of molten metal by a mica screen placed over the electrodes (Fig. 17). The machines are also surrounded by a hood to prevent the shower of sparks given off from injuring anyone standing in their neighborhood.

Workmen at the large lathes (Fig. 9) were formerly subjected to considerable danger owing to the fact that they could not reach the disengaging lever from the point at which they were standing. For this reason the AEG disengaging devices, which are connected with the controllers, are led around the entire circumference of the table. In order to prevent the premature insertion of the hand in the rotating drums of centrifugals, the latter are provided with double covers (Fig.19)

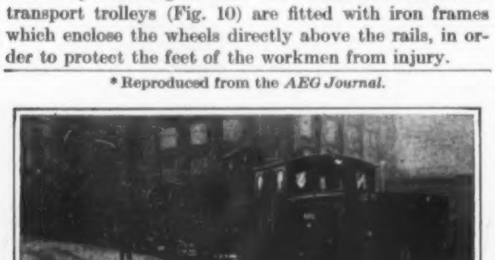


Fig. 8.—Railway traffic in the extensive factory yards.

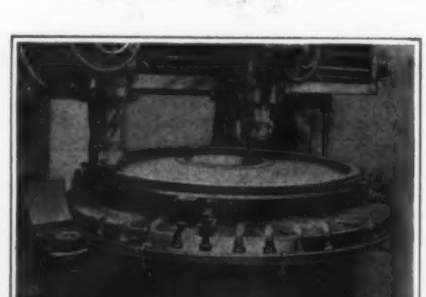


Fig. 9.—Disengaging device on an electrically driven lathe.

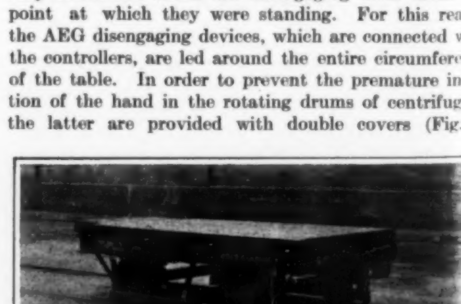


Fig. 10.—Transport trolley with wheel protection.

Fig. 11.—Grinding machine with protecting hood and suction device.

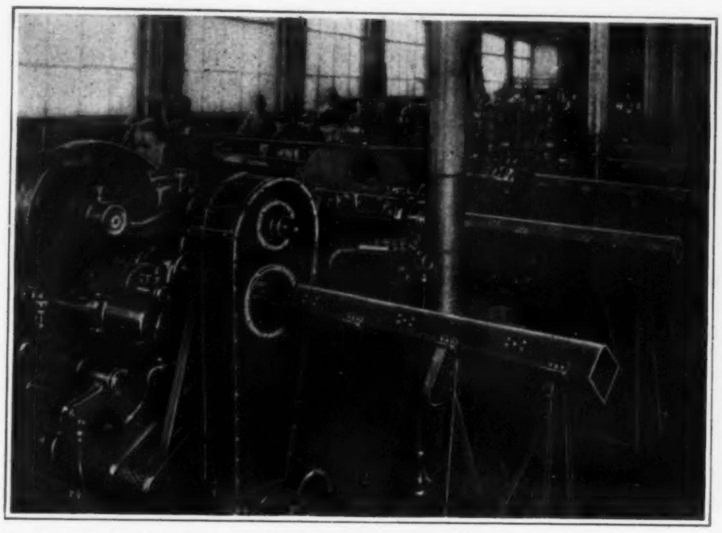


Fig. 12.—Slicing lathes with protecting devices over the rods of rotating material.

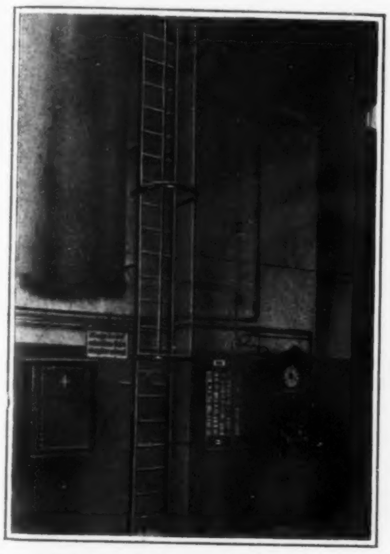


Fig. 13.—Crane ladders attached to walls are fitted with back bars.

Fig. 14.—Benzine washing apparatus with automatic extinguishing device.

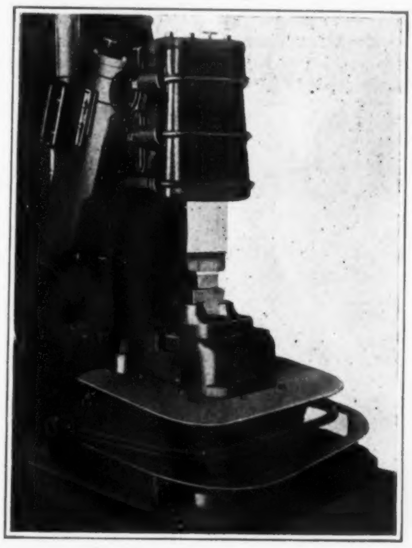


Fig. 15.—Protecting cover over the foot lever of a compressed air hammer.

which can only be opened when the machines are stationary, or with a single cover (Fig. 6) which is connected to a belt shifting device is such a manner that it is impossible to open the drum while it is in use.

Particular care is taken to prevent accidents to the eyes (Fig. 2). Workmen working with the chisel must wear protecting goggles. The workmen employed in autogenous or electric welding (Fig.16) must be protected by colored glasses, helmets, asbestos gloves, leather aprons, etc., against the injurious effects of light and heat. Ample precautions are also taken in the caustic works (Fig. 18) for drawing off the nitrosulphuric gases through stoneware exhausters, and for the precipitation of the gases in stoneware towers. Open forge fires have a draught for carrying off the smoke in every case. Straight ladders are fitted at the ends with points, or with rubber or lead in order to prevent slipping. Crane ladders attached to vertical walls (Fig. 13) are fitted with back bars. The washing apparatus (Fig. 14) in which metals are washed with benzine is equipped with devices which, on the ignition of the benzine, immediately allow an extinguishing mass to fall or cause the lid of the apparatus to come down. The throwing-in levers for compressed air hammers (Fig. 15) which move vertically, have a protecting cover placed above them in order to prevent any pieces of iron which may fall off the anvil from causing the machine to start prematurely. In the grinding department (Fig. 11) the emery discs are surrounded by strong hoods and are also provided with exhausters which carry off the unhealthy grinding dust. A great source of danger exists in the turret lathes (Fig. 7) or similar machines, owing to the ends of rotating material which project from the machine, on which account these ends are placed in protecting tubes (Fig. 2).

It must not be overlooked that the hair of female workers, which is often elaborately dressed, also forms a source of accidents. The protecting headgear (Fig. 3) has, therefore, been introduced for female workers employed at machines. In addition, all rotating parts

Fig. 16.—Protecting devices for the electric welding process.

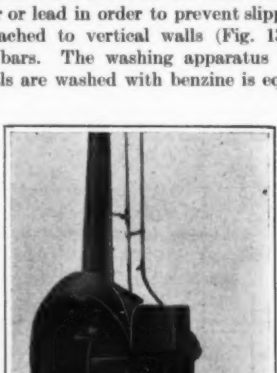


Fig. 17.—Protecting devices on an electric welding machine.

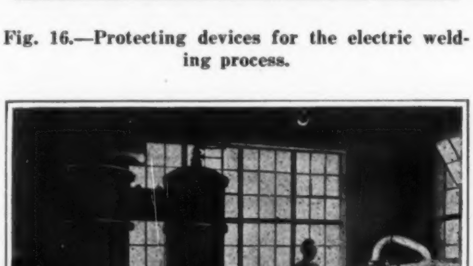


Fig. 18.—Caustic plant with self-contained vats and means for drawing off the nitrosulphuric gases.

Fig. 19.—Centrifugal with a double cover and disk protection.

Fig. 20.—Ambulance station.

Fig. 21.—Ambulance motor wagon.

of the machines such as spindles, shafts, etc., are carefully covered to prevent accidents as far as possible.

These are a few examples of the precautions taken for the prevention of accidents in the AEG factories.

As, however, it is impossible to avoid accidents altogether in very large works, ample provision is made in the AEG factories for first aid; stretchers are available everywhere, and an ambulance station (Fig. 20) equipped with the latest medical and hygienic apparatus can render valuable assistance to injured or sick persons. Motor car ambulance wagons (Fig. 21) are employed for conveying injured persons to their dwelling or the hospital.

The AEG devotes its constant interest to the further improvement of all these arrangements in the hope of still further reducing the number of accidents occuring.

Contributions to the Technology of the Paper Industry*

The Influence of Soda Consumption in Boiling Upon the Yield of Pulp Produced

By Clayton Beadle and Henry P. Stevens

In the investigation of any fiber for service in the manufacture of paper the determination of the soda consumption is of primary importance. We generally proceed first of all by boiling with excess of soda, say twice that which is likely to be consumed, when at the termination of the boiling, the soda consumed is estimated and a second boiling is carried out with the amount of soda found to be consumed in the first. If the material is now insufficiently boiled, a third boiling is made with one fifth more soda than is contained in the previous one. This is likely to leave some soda in excess at the end of the boiling. If now the material in the third boiling is found to possess the requisite qualities in regard to beating, bleaching, etc., the amount of soda in the third boiling is regarded as the commercial quantity. More frequently, however, a greater number of boilings is required in which the conditions as to pressure, time, concentration of liquor and so forth are varied.

It is important, furthermore, to determine the soda consumption from hour to hour as the boiling progresses, in order to ascertain how long the boiling should be continued. For this purpose we blow off every hour or every half hour a sufficient amount of liquor, say 100 c.c., and determine the free and total soda, calculating the combined by difference and expressing the combined as a percentage of the total. The free soda can be sufficiently accurately estimated by carefully titrating the liquor with normal sulphuric or hydrochloric acid, transferring drops periodically to neutral litmus paper made with specially sized paper. As the liquor is frequently intensely colored the effect on the litmus paper is observed after flicking off the drop. The total soda is merely determined by incineration and titration in the presence of methyl orange.

In order to check the accuracy of our methods we have evaporated liquors to the consistency of a thick dough and proceeded with the examination of this mass on the lines of ordinary soap analysis which gives for the free and combined soda almost identical figures with those obtained as above, with the original dilute liquors.

To save time, one can merely determine the free alkali and, knowing the soda and the volume of the liquor originally added, calculate the combined. This, however, is only approximately accurate on account of the fact that the free mother liquor which drains from or is blown off from the boiled material, is of a different concentration from that which is soaked up by, and remains in close contact with it. This is due to the fact that there is an absorption of the alkali by the material. The same absorption is found to take place on the mercerization of cotton when the mother liquor draining or pressed from the mercerized mass is found to be of less strength than that which remains in close contact with the cotton. It also takes place, as we have recently demonstrated, when monofils of regenerated cellulose are exposed to caustic soda solutions in the cold in dilutions between 1 and 6 per cent NaOH and for greater concentrations if the solution is raised in temperature.[1]

In laboratory investigations the best way of obviating this difficulty is to wash out the whole of the liquor at the end of the boiling, make up to a given volume, determine the free and combined soda and calculate to weight of raw material under treatment. In large scale operations, where this is not possible, we determine the free and combined soda in the mother liquor and, knowing the percentage of soda added in the first instance on the weight of raw fiber treated, we calculate the free and combined as a percentage on the raw fiber. Some fibers such as cotton, linen rags and esparto, are treated so as to purposely contain an excess of soda at the end of the boiling. Others, such as *Hedychium* (which is typical of the manila) class, is required to contain no free soda. Fig. 1 shows two average soda exhaustion curves, in one case for boiling cotton rags, and the other for *Hedychium*.

It is generally known that the greater the amount of soda employed, i. e., the more drastic the treatment, the lower the yield. Sutermeister has, as the result of a large number of determinations, established a relationship between the yield and the soda consumption of spruce and poplar.[2]

In order to ascertain whether similar results are to be obtained when treating other materials, we have taken the results obtained with *Hedychium* and plotted a curve (Fig. 2) with the abcissæ as yield and the ordinates as soda consumption, against which, on the same figure, we have given Sutermeister's curve for spruce. It will be observed on comparing the two, that the curves are very similar. We have in the case of spruce a critical soda consumption of 15 per cent and for *Hedichyum* 5 per cent. At 5 per cent *Hedychium* is sufficiently boiled for the production of commercial papers and above this percentage of consumption there is no benefit. It will be observed in both cases that there is a curve up to the critical soda consumption above which there is a straight line. From the critical point upwards in both cases the loss per unit of soda consumption is a constant

* Paper read before the Manchester Section of the Society of Chemical Industry, and published in the *Journal* of that society.

[1] The influence of temperature on hydration and absorption of soda by regenerated cellulose. Eight. Int. Cong. Appl. Chem. 1912. Vol. 13, page 25.

[2] Wood; Consumption of caustic soda in cooking (pulping) ——, and its influence on the yield and bleaching properties of the fiber. E. Sutermeister. Eighth Int. Cong. Appl. Chem. 1912. Sect. VIa. Orig. Comm., 13, 265-269.

Soda exhaustion on boiling cotton and hedychium.

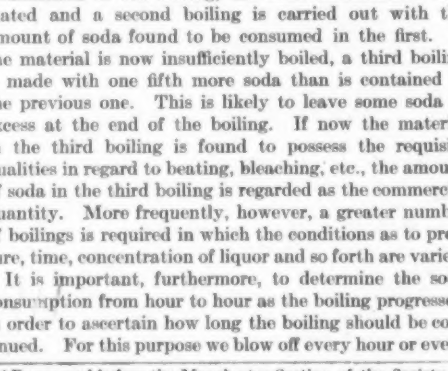


Fig. 1.—Two average soda exhaustion curves.

Hedychium.—Comparing the soda consumption, during boiling, with the yield of unbleached pulp produced.

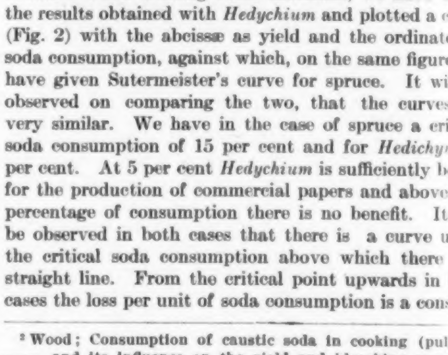


Fig. 2.—Curves for Hedychium and for Spruce.

quantity. In the case of *Hedychium* the average loss (0—15 per cent NaOH) per unit of soda consumed is 1.66 and in the case of spruce the average (0—22 per cent. NaOH) is 3.25. Therefore the matter rendered soluble per unit of soda consumption is double in the case of the spruce as compared with that of *Hedychium* with

Hedychium.—Showing the effect of time occupied in Beating upon the rates of drainage on the Paper Machine.

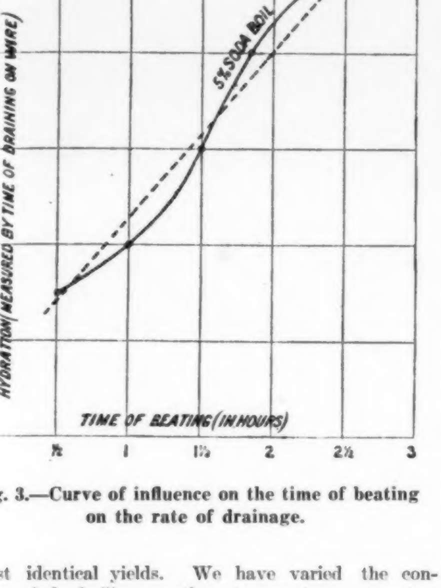


Fig. 3.—Curve of influence on the time of beating on the rate of drainage.

almost identical yields. We have varied the conditions of the boiling *qua* time, temperature, concentration and so forth, and we furthermore confirm the views of Sutermeister that the yield and in a large measure also the qualities of the product obtained are dependent upon the soda consumption alone and are not influenced by the other conditions.

THE INFLUENCE OF TIME OF BEATING UPON THE RATE OF DRAINAGE FROM THE MACHINE WIRE OF THE PAPER MACHINE.

The rate of drainage is conditioned in some way by the wetness of the stuff, and this again by the beating and previous chemical treatment. No two kinds of material behave alike in this respect, consequently the question of drainage requires the exercises of a good deal of ingenuity on the part of the paper maker. He is, however, materially assisted by many modern contrivances which promote the flow of the water with the assistance of gravitation and suction. The greater the amount of natural drainage, however, the better for the paper maker. Generally speaking, *ceteris paribus*, the more "free" the stuff, the more rapid the drainage or the "wetter" the stuff the slower the drainage.

For the purpose of determining the change in the "free" working of a raw material as the result of chemical treatment and quite apart from the subsequent beating, the following method has been devised and usefully employed. Taking the case of cotton, this is taken in the air dry state, pressed into loose wads 15×10 mm., weighing 0.1 gram. The wads are let fall from a certain height on to the surface of a column of water and by means of a stopwatch the length of time necessary for the stuff to pass through the surface is noted. A tall glass jar is used for the purpose and the surface of the liquid kept on a level with the eye so that the operation can be carefully observed. The following figures are determined in the manner above cited:

	Mean of 4 Tests.
Cotton wool (ordinary) more than..........	24 hrs.
Bleached but unboiled short-fibered cotton..	31.3 secs.
Cotton once boiled in 1 per cent caustic soda	12.3 "
" once boiled in 2 per cent caustic soda	5.7 "
" boiled and bleached and boiled again	4.0 "
" after extraction with ether and alcohol	0.5 "

Thus, raw cotton floats on the surface like a feather and properly purified cotton will sink through the surface in half a second.

The rate at which pulps are wetted, as indicated by the above method of testing, has some connection with the rate at which the free water drains away from a pulp. As the pulp passes on to the paper machine, it contains about 98 per cent of water and 2 per cent of fiber. A modern paper machine travels at the rate of 5 to 10 feet per second and the length of the machine wire is about 25 feet. Consequently, in order that the bulk of the free water may have passed off before the material reaches the suction boxes, it is necessary that it should drain away very rapidly. On the other hand, too rapid drainage detracts from the felting qualities of the paper.

In order to ascertain what influence the time of beating had upon the rate of draining, we made determinations with *Hedychium* pulp, making tests at every half hour up to 3 hours' beating, the results of which are shown on the accompanying diagram. (Fig. 3.)

These results seem to indicate a wavy line of S curve, but on the whole a fairly uniform rate of progression in the wetness and resistance to draining as measured in this way.

THE INFLUENCE OF SODA CONSUMPTION AND TIME OF BEATING ON THE SHRINKAGE OF PAPER.

The shrinkage of paper and what is known as the register of watermarks is largely controlled by the time occupied in beating as well as by the more or less drastic method employed in beating. It is however partly controlled by such means as tension put upon the web in the course of manufacture. Sometimes the register of a watermark, that is, its exact position in the sheet, is corrected by emptying into the stuff chest an additional engineful of stuff beaten either wetter or more free than the rest, according as to whether more or less shrinkage is required. In addition to the actual beating the amount of soda consumed in the boiling of the material prior to the beating is a determining factor. The diagram records the results of our tests with *Hedychium* paper made at different stages of the beating.

For each stage in the beating a large number of observations were made and the average taken (at least 20 measurements in each case) and to eliminate the opposing effects of tension, the sheets were allowed to shrink freely while drying.

As will be seen from the diagram (Fig. 5; the abscissa of which represents the time of beating in hours and the ordinate the lineal shrinkage on drying as a percentage of the wet length of the paper), the shrinkage is rendered greater by increasing the soda consumption as well as by prolonging the time of beating.

Measurements made on paper prepared from other materials led us to conclude that other paper-making materials behave in a similar way to that recorded for *Hedychium* and that any differences that may exist between different materials are a matter of degree rather than of kind.

THE EFFECTS OF SODA CONSUMPTION AND TIME OF BEATING UPON THE BREAKING LENGTH AND BURSTING STRAIN OF PAPER.

The figures herein recorded in the case of breaking length represent the length of a strip of paper which, if suspended freely in still air from a great height, would just break with its own weight. The figures for bursting strain are expressed in pounds per square inches as is the general custom in this country.

These two expressions, which are used commercially for indicating the strength of papers, do not vary in the same proportion and their relation to one another varies with different kinds and qualities of paper. For certain commercial purposes the breaking length is taken as the citerion, whereas with others more importance is attached to the bursting strain. A close study of these two modes of expressing the strength of paper for the purpose of establishing any relationship between the two has never been made.

As furnished to the beater, the boiled material consists

Hedychium.—The influence of time of Beating upon the shrinkage of the Paper.

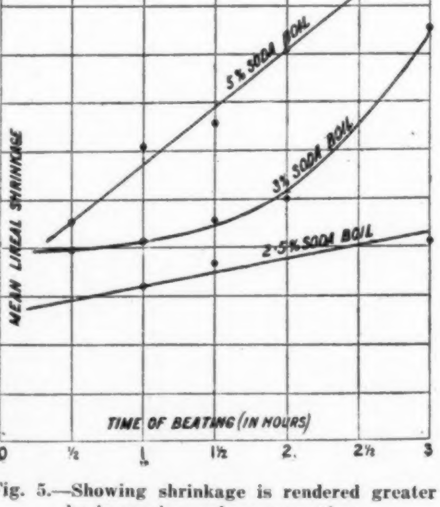


Fig. 5.—Showing shrinkage is rendered greater by increasing soda consumption.

in the case of *Hedychium*, Manila, and such fibers of threads (i. e., fibro-vascular bundles), the dry breaking length of which is about 60,000 meters and, as the average breaking length of a paper producible from this or any other strong fiber cannot be made to exceed about 10,000 meters, the fiber bundles have in the dry state

Hedychium.—Showing the effect of time occupied in Beating upon the Breaking Length and Bursting Strain of Paper.

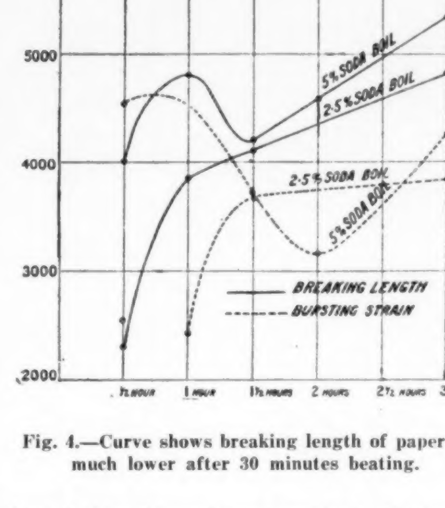


Fig. 4.—Curve shows breaking length of paper is much lower after 30 minutes beating.

about six times the maximum strength of a felted paper producible from the ultimate fibers composing the bundles.

On prolonged wetting in water alone, the breaking length of these threads is diminished by about one half and to a lower figure when acted upon by soda, but this breaking length resumes more or less its original value when the material is dried again.

At the early stages of beating the threads are only in part reduced to the condition of ultimate fibers, the paper being of a very hairy nature, this hairiness diminishing as the beating proceeds. The hairiness at the incipient stages of beating is due to the presence of threads, i. e., fibro-vascular bundles which in themselves possess a relatively high strength as already explained. Hence it is that a fictitious strength is given to such paper. As the beating proceeds, the fiber bundles become separated into ultimate fibers and the paper has to rely more for its strength upon the *felting* qualities of these *ultimate* fibers as distinct from the fiber bundles. The felting qualities, which are comparatively low at the early stages, gradually increase with the beating. Hence, in the case of 5 per cent soda (Fig. 4), with one and a half hour's beating where the hairiness is rapidly disappearing but the felting strength is still low, the breaking length of the paper as indicated by the curve is much lower than at a somewhat earlier stage, e. g., after one hour's beating. These observations apply to properly boiled stuff in which 5 per cent of soda has been consumed.

In the case of a much lower percentage of soda consumption, as when the boiling is incomplete, the circumstances are somewhat different. Here (with 2½ per cent soda) the tenacity of the threads (fiber bundles) offers such resistance to the separation of the ultimate fibers as to ensure their hydration as rapidly as they become separated. This results in an increase of strength, the curve showing a continuous rise from the first half hour onwards, in place of a fall followed by a subsequent rise as when a 5 per cent soda is used for boiling the material. In all cases, however, for equal times of beating it will be observed that the smaller amount of soda gives the lower breaking length.

As the bursting strain of paper varies with the thickness, it is important to note that the substance of the paper made in each case was 20 pounds Demy equal to 74 grms. per square meter, with a thickness of 0.10 mm.

Turning to the bursting strain figures as indicated by the dotted line, it will be noticed in the case of 5 per cent NaOH that after the first hour there is a diminution of breaking length but that the bursting strain comes to a minimum at a later stage in the beating, that is, at about 2 hours instead of 1½ hours—that is, it lags behind the breaking length, after which it rapidly rises.

In the case of the 2½ per cent soda consumption (i. e., incompletely boiled material), the bursting strain rises rapidly up to 1½ hours beating, after which, on further beating up to 3 hours, only a slight rise is noticed. In this case also the bursting strain follows and lags behind the breaking length.

These results indicate that there is some connection between bursting strain and breaking length.

Forest Products Laboratory, Madison, Wis. Conducted by the Forest Service of the United States Department of Agriculture in co-operation with the University of Wisconsin.

Pulp grinder and "wet machine" in laboratory. The pulp-making equipment in this place is similar in many respects to that of a commercial plant.

The Octopus of the Spruce Forest

An Equipment That Every Minute Devours One Log a Foot in Diameter and Ten Feet Long

By William H. Kempfer

IMAGINE a machine that every minute devours a log of wood a foot in diameter by ten feet long and disgorges in the same time five hundred complete newspapers, printed and folded. This, practically, is what modern industry has accomplished. Although we have not yet learned to combine the two processes of paper manufacture and printing in one operation, the presses in a large daily newspaper plant deliver the printed papers at this lightning speed, while the paper mill or group of mills that keep the printing presses supplied produce the paper from the log with about as remarkable a dispatch.

A single New York daily newspaper requires for its morning edition of 415,000 copies sixty-two tons of paper. To produce this, the wood from ten acres of ordinary spruce forest is consumed; in the course of a year, for week-day and Sunday editions, from four thousand to five thousand acres are denuded of their timber. If the cutting is so conducted that only an amount equal to the annual growth on a given area is taken, from 100,000 to 125,000 acres of spruce land are necessary to keep this one daily supplied with printing paper. Including big and little, there are about 2,500 daily newspapers in this country, and the one referred to in the above example is probably not the largest user of paper among them.

The production of news printing paper in the United States, according to the census reports for 1909, was 1,176,000 tons, which is more than double that of ten years before, and exactly six times the production of twenty years ago. The mills manufacturing this paper are dependent upon spruce for pulpwood and are mostly located in New England, New York, and the Lake States. But the cut of spruce in these States, as shown by the statistics for consumption of domestic pulpwood, seems to have reached a maximum, and actually decreased from 1,786,000 cords in 1906 to 1,474,000 cords in 1910. These amounts were augmented by large importations from Canada, amounting to two-fifths of the domestic supply in the former year and to three-fifths in the latter. Moreover, in 1910, 424,000 tons of manufactured wood pulp were imported as against 176,000 tons in 1906.

A few years ago, Mr. Pinchot, then Chief of the United States Forest Service, estimated that with the current rate of cutting, the stand of spruce in Maine would be exhausted in less than thirty years. New Hampshire, according to the same estimate, had twenty-five years' supply, while New York had less than ten years' cut in sight. Wisconsin, with thirty-three ground-wood pulp mills, having a combined annual capacity of nearly three hundred thousand tons, has no large stands of spruce timber and the mills are dependent for their supply on scattered bodies on the small holdings of settlers or must import wood from other States and from Canada. Canada has probably from two to three times as much spruce as the United States, but the exportation of timber cut on the Crown lands of Ontario is forbidden, while Quebec grants a rebate on wood manufactured at home equivalent to an export duty of 25 cents per cord.

While estimates of standing timber are subject to frequent revision as more information becomes available, it is not necessary to look far into the future to find need for action which will insure an adequate supply of cheap printing paper. Within ten years, the average cost of spruce pulpwood cut in the United States increased from \$4.83 per cord to \$9.32 per cord, and imported spruce increased from \$6.50 to \$11.34 per cord. During the same period, the cost of manufacturing ground-wood pulp, as determined by the Tariff Board, increased \$5.74 per ton, of which 93 per cent. was accounted for by the greater cost of the wood used. An increase of \$5.00 per ton in the price of paper means 1/16 of a cent on every copy of a 16-page newspaper, or \$250 per day for a paper of this size with 400,000 circulation—an amount sufficient to pay 6 per cent dividend on an investment of \$1,500,000. To offset the increased cost of the paper, a general increase in the price of daily newspapers has at various times been proposed by the publishers.

Grinder room in pulp mill.

As a means of increasing the available supply of materials and keeping down the cost of production, the pulp and paper manufacturers urged trade agreements that would remove Canada's embargo on pulpwood. The newspaper publishers, insisting that the manufacturers were charging them excessive prices, demanded and finally secured, in so far as a large part of Canada's production is concerned, the removel of the tariff on printing paper. In the meantime, an attack on the problem was initiated from another direction, which promises important results.

In June, 1910, Congress made a special appropriation of \$30,000 for testing woods to determine their suitability for paper pulp. While the Act did not state specifically how this sum should be expended, it was well known that the object of the appropriation was to find substitutes for spruce in the mechanical or grinding process of pulp-making, the process by which most of the pulp entering in the manufacture of cheap printing paper is produced.

In both the sulphite and the soda processes, the former employing sulphites and bisulphites of calcium and magnesium, and the latter caustic soda to separate the wood fibers, large quantities of hemlock, poplar, and various other woods, in addition to spruce, are used. High grade papers have been made experimentally from rice straw, cornstalks, and bagasse, the waste from the sugar cane mills; bamboo, which can be grown readily as a crop plant in many parts of the country, is also suitable for papermaking. In England a grass known as esparto is extensively employed. Theoretically, paper may be made from any fibrous vegetable material, but none of the materials other than wood, which have been used or suggested, offer a solution to the problem of cheap print paper, the life of modern newspaper industry.

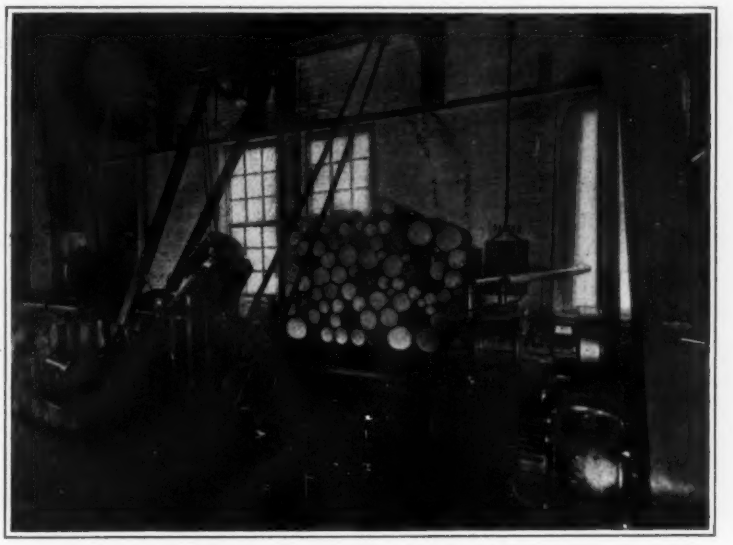
Few of the annual crop plants and waste materials can successfully compete with wood for the manufacture of pulp when costs and yields are taken into account. Moreover, the yield of pulp from wood reduced chemically is but little more than half that obtained mechanically; for this reason chemically-made pulps cannot compete with mechanical pulp for the production of cheap white paper. However, ground-wood requires the addition of about 20 per cent of the longer-fibered sulphite pulp to give it strength.

Notwithstanding the uncertain supply of spruce, and prices that have doubled within ten years, no serious attempt seems to have been made by the ground-wood mills to employ other woods. Just why hemlock, of which there are abundant supplies in Wisconsin, where the shortage of spruce has been keenly felt, is not more used cannot be fully explained, although it has been claimed that the fibers grind very fine and short and that a large portion of the wood is lost in converting it into pulp.

The need for the experiments made possible through the action of Congress is strikingly shown by the interest of the American Pulp and Paper Association in the investigation. An advisory committee was formed to co-operate with the Forest Service, to whom the fund had been allotted, in planning and carrying out the experiments. To the chairman of this committee, Mr. G. F. Steele, Vice-President of the Association, and Secretary of the Nekoosa-Edwards Paper Company, and to other members of the committee belongs much of the credit for getting the enterprise properly on its feet. Wausau, Wisconsin, was selected as the place for locating the laboratory, because of its nearness to a number of big pulp mills, which would make easier a comparison between the results obtained in the grinding tests and those obtained commercially.

In the grinding of pulp the wood, freed from bark and cut into two-foot lengths, is held with its side

View of a wood yard of a pulp and paper mill.



Wood prepared for grinding in pulp making experiments.

against the face of a rotating stone, which is covered with an iron casing. What are known as "pockets" are provided in the casing for the reception of the wood, and pistons operated by hydraulic pressure hold it firmly against the stone. The fibers are torn away by the friction of the stone and a constant stream of water carries the pulp into a pit below the grinder.

In order to ascertain whether it is commercially feasible to grind wood other than spruce for paper pulp, it was necessary to make the tests in such a manner that they would be comparable to actual commercial practice. For this purpose, commercial-size apparatus was needed. The amount appropriated by Congress would have been insufficient to even purchase the required equipment—leaving nothing for carrying on the tests—but the plan which had been formulated was made possible by the assistance of various manufacturers of pulp-mill machinery, who loaned, without charge, much of the necessary equipment.

The pulp-making equipment of the laboratory is similar in many respects to that of a commercial plant, but consists of a single unit only; whereas the commercial plant may have six, eight, or more grinders, the laboratory has but one, and other equipment is in like proportion. However, in one important detail the experimental laboratory differs from the commercial plant—provision has been made for precise measurement of power. Knowing how much power was applied to the grinder over a given period and how many pounds of pulp were ground, the number of horsepower required to grind one ton of pulp in twenty-four hours, or the amount that may be ground in this length of time by a given amount of power can easily be calculated. By such means, it may readily be seen how other woods compare with spruce in the amount of pulp that a mill can turn out and in the cost of grinding it.

The woods first considered in the experiments were jack pine and hemlock. Not only was a good grade of pulp obtained from both species, but paper was made from the pulps on commercial machines, operating at high speed and under all other conditions of commercial practice, which has the strength, finish, and, except for a slight difference of color, the appearance of standard news paper. From 85 to 87 per cent of the weight of the wood which was ground was recovered in the pulp, a yield approximately the same as occurs in the grinding of spruce. The pressure of the wood upon the revolving stone, the speed of the stone, and the condition of the surface, by which these results were obtained, were also not radically different from the conditions that prevail in the grinding of spruce. Likewise the rate of production for a given amount of power, and the power consumption per ton of pulp were similar.

Spruce wood has an even grain and comparatively long fibers. In grinding it, a fairly good pulp is obtained under almost any conditions, and with very little attention to the details of the process. In the grinding of hemlock, on the other hand, care must be exercised in bringing the stone to the correct degree of sharpness, since the wood will grind to powder if the surface is as sharp as the one ordinarily employed in the grinding of spruce. The change from spruce to hemlock may necessitate a more-skilled and better-paid man in the grinder room. Such a result, doubtless, will not be altogether an evil, inasmuch as a prominent manufacturer has asserted that there is no business within his knowledge where the details are not given closer attention than in the paper business.

This condition was strikingly brought out when a precise comparison of the experimental results with the standards of commercial mills grinding spruce was attempted. Inquiry among various mills disclosed that such factors as the pressure, and speed of the stone, the condition of its surface, and the power applied to the grinder varied greatly even in mills supposedly producing similar products. From the data collected it was impossible to tell what were the conditions of grinding favorable to the best quality of pulp or the maximum production with the use of a given amount of power. An exhaustive series of tests was therefore undertaken on spruce to determine the relations between the various factors which enter into the grinding of wood pulp. The results of these tests are efficiency standards for the pulp mill operator. The tests show, for example, that the power consumed in grinding one ton of pulp is decreased by increasing the pressure of the wood on the stone; the same is true of increasing its sharpness. Variation in these conditions, of course, affect the horsepower that must be applied to the grinder and the quality of the pulp which is produced, but with the curves before him, giving values for these various influences, the operator may adjust his grinding conditions so as to obtain the maximum production of pulp per day of the particular quality he is desirous of making.

Spruce forest where the paper came from.

Jack pine occurs extensively on the poorer class of soil in Michigan, Wisconsin, and Minnesota. The wood has at present little commercial value, and its general use for pulp would go a long way towards solving the present somewhat troublesome problem of its profitable utilization. Hemlock is a widely-distributed species and is accessible to practically all mills now using spruce. Although much has been cut for lumber, larger quantities of standing timber still exist, notably in the lake States. The use of either of these woods, if a marketable product can be manufactured, will give a new lease of life to mills whose future has been threatened by the growing scarcity of spruce. That the slight differences in color between the sheet composed of spruce ground-wood and that composed of substitute species will occasion a prejudice against the latter sufficient to affect seriously its market value is a possibility which must be reckoned with by the manufacturer.

Tests were made also with a number of western woods and some of these have been found suitable to the requirements of the ground-wood pulp mill. A few mills have been in operation on the Pacific Coast, supplying local needs, but with better knowledge of what woods are available, and the opening of the Panama Canal, which will permit the western manufacturer to lay down his product in eastern markets in competition with the mills closer at hand, it seems certain that the manufacture of pulp and paper will soon become an important industry of the Northwest.

Large as is the consumption of wood for the manufacture of paper pulp, the total amount used annually for this purpose, including both mechanical and chemical processes of manufacture, is scarcely one-twentieth the annual lumber cut. The situation in regard to the ground-wood industry is serious, chiefly because it demands spruce wood and only spruce. While the sulphite process of pulp manufacture consumes more spruce than the grinding process, and the total wood consumption by all chemical processes is nearly three times as great as the amount reduced by grinding, no shortage of supplies has been experienced by the chemical mills which in any way compares to that felt in certain sections by the mechanical mills. This is because the chemical mills are not dependent to so great an extent on any single species, but are able to use the material most available, and are using increasing amounts of slabs and other forms of sawmill waste. And in the southern yellow pine region alone there is as much material wasted in the form of tops and defective logs left in the woods and slabs burned on the refuse heap as is consumed by all processes of paper manufacture!

While letting down the tariff bars may relieve the print-paper situation for the time being, so far as the publisher is concerned, eventually, just as we look to next year's wheat crop for our next year's bread supply, so must users of forest products consider the tree as a crop and depend upon future growth for future supplies. The closer utilization resulting from the employment of a variety of species for purposes hitherto requiring a single one, or from the use of species not previously in demand, is a long step forward toward profitable forest management.

Copper Wire by Electro-deposition

According to the *Brass World*, W. E. Gibbs has devised a process for the manufacture of copper wire by electro-deposition. Previous attempts to accomplish this object have been unsuccessful.

The Gibbs method requires a fine copper wire as a core for making the desired product, and the additional copper is deposited on it while it moves through a tank containing the solution. The fine copper wire is made endless and passed through a regular plating solution containing sulphate of copper and a little sulphuric acid. The wire passes over grooved rollers operated from outside while passing through the tank. After leaving the tank, the wire passes through a small rinsing tank to remove the solution, and then goes to a reel around which it passes a number of times, returning again to the plating tank. The plating may thus be continued until the required thickness is obtained.—*The Journal of Industrial and Engineering Chemistry.*

The Hydro-Aeroplane Meeting at Deauville*

A Summary of the Results

As a prelude to the important and epoch-making event—the hydro-aeroplane Meeting at Deauville, August 25-31—a race for these machines was held over the Seine, Paris being the starting point and Deauville the finish.

The race was open to all nations, though only French machines competed. It was necessary for each machine to carry a passenger, though one could be substituted by a weight of 70 kilogrammes. The weather conditions were favorable, but the course—through densely-wooded regions for the greater part—was by no means an easy one.

A terrible fatality occurred at Rouen, the pilot de Montalent and his mechanic Métivier being killed. The machine, presumably, was struck by a violent remou, for, at an altitude of about 300 feet, it was seen to dive and fall on the right-hand side of the river. Both were killed on the spot.

The results were as follows: (1) Chemet, on an 80-horse-power Gnome-Borel, in 3 hours 47 minutes 50 seconds; (2) Levasseur, on a 160-horse-power Gnome-Nieuport, in 7 hours 38 minutes 15 seconds; (3) Molla, on a 100-horse-power Gnome-Lévêque, in 8 hours 46 minutes 11 seconds; and (4) Janoir, on a 100-horse power-Gnome-Deperdussin, in 10 hours 11 minutes 4 seconds. Levasseur was subsequently disqualified for not having followed the exact course.

The other starters who did not finish were: Weymann (Nieuport), Prévost (Deperdussin) Rugère (Bathiat-Sanchez) de Montalent (Breguet) Divetain (Borel-Laéroyacht).

The two Breguets piloted by Brégi and Moineau remained at Havre.

On Monday, the next day, the actual *Concours d' Avions-Marins* commenced. The machines ready to compete were:

1. Maruice Farman biplane piloted by Renaux
2. " " " " Gaubert
5. Caudron biplane " " R. Caudron
6. " " " G. Caudron
10. Deperdussin monoplane " Prévost
11. " " " Janoir
12. Borel " " Chemet
13. Dussot " " Bosano
15. Lévêque biplane " Molla

Entries 8 and 9, the two Breguet biplanes piloted by Moineau and Brégi, were ready for work, but remained at Le Havre. No. 3, Weymann's Nieuport, arrived during the morning. The Dussot, with Bosano on board, dived into the sea, and inflicted somewhat severe injuries on its pilot.

The two Breguets started operations by passing the test of navigability, describing a figure of 8 between two buoys placed 400 meters apart. They were then subjected to an examination after having been moored for one hour, and subsequently succeeded in effecting *décollage* (rising from the water), in a lesser distance than 400 meters. The test of navigability was also accomplished by Caudron on one of his own machines (an amphibian), and by Chemet. Moineau passed the altitude test on his Breguet, rising to 1,700 feet in 7½ minutes.

On the next day the sea remained calm. It should be remembered, however, that Deauville, being practically in the mouth of the Seine, is extremely fortunate in this respect, similar weather conditions being by no means prevalent elsewhere. A curious accident, happily without serious results, occurred to the machine piloted by René Caudron. Leaving the water after a short run, he rose a foot or so into the air, when his floats were struck by an approaching swell. The machine promptly dived into the sea and dissappeared temporarily though the two occupants were rescued without injury.

The test of *étanchiété* in which the floats of a machine were examined after a period of mooring for one hour in the open sea in order to determine the extent of their water tightness was passed by Levasseur, Chemet and Molla.

At the end of the second day the position of the competitors was as follows on machines having passed those tests adjoined to them: (1) M. Farman (Renaux): figure of 8; (4) Nieuport (Levasseur); figure of 8 *étanchiété, mouillage and décollage;* (8) Breguet (Moineau) figure of 8 *mouillage, décollage* and altitude; (9) Breguet (Brégi) speed range of action figure of 8, balance *mouillage, décollage* and altitude; (10) Deperdussin (Prévost) figure of 8 and *décollage;* (12) Borel (Chemet) speed range of action *étanchiété* and *mouillage;* (15) Lévêque (Molla) speed range of action *étanchiété, mouillage, décollage* and altitude.

No.	MACHINE	PILOT	ENGINE	FLOATS	LENGTH	SPAN	AREA
					ft	ft.	sq. ft.
1	**Maurice Farman b.**	Renaux	120-h.p. Renault ...	Tellier type ...	32·8	62·3	645
2	**Maurice Farman b.**	Gaubert	120-h.p. Canton-Unné	Tellier type ...	32·8	62·3	645
3	**Nieuport m.**	Weymann	160-h.p. Gnome ...	Nieuport	28·5	44·6	322
4	**Nieuport m.**	Levasseur	120-h.p. Canton-Unné	Nieuport	28·5	49·2	430
5	**Caudron b.**	René Caudron ...	120-h.p. Canton-Unné	Caudron	29·5	59·0	430
6	**Caudron b.**	Gaston Caudron ...	100-h.p. Anzani ...	Caudron	26·2	49·2	344
7	**Bathiat-Sanchez b.**	Molla	160-h.p. Gnome ...	Bathiat-Sanchez ...	32·8	43·3	495
8	**Breguet b.**	Moineau	200-h.p. Canton-Unné	Fabre & Tellier ...	32·8	50·2	484
9	**Breguet b.**	Brégi	200-h.p. Canton-Unné	Fabre & Tellier ...	32·8	50·2	484
10	**Deperdussin m.** ...	Prévost	200-h.p. Gnome ...	Tellier	32·8	44·6	377
11	**Deperdussin m.** ...	Janoir	160-h.p. Le Rhone ...	Tellier	29·5	43·3	300
12	**Borel m.**	Chemet	80-h.p. Gnome ...	Borel	27·1	34·7	194
13	**Dussot m.**	Dussot	100-h.p. Anzani ...	Dussot	24·6	42·6	280
14	**Astra b.**	Count de Lambert ...	160-h.p. Gnome ...	de Lambert ...	39·4	52·5	645
15	**Lévêque b.**	Molla	120-h.p. Canton-Unné	Lévêque	26·2	41·0	312

On the 27th several pilots continued to pass the various tests and the monotony of the one hour mooring tests for the competitors was relieved somewhat by many interesting exhibitions given by several pilots. Henri Farman piloted a hydro-byplane of his own construction and performed many excellent feats. This machine which is shown in our front page illustration is an ordinary type of machine fitted with well-sprung floats, the extent of possible movement being as great as, if not greater than that on any machine existing. The Dunne biplane a machine without floats visited the scene of operations under the pilotage of Commandant Felix and astounded the spectators with its novel appearance and evident ease of control. A Nieuport piloted by Bertin also was seen overhead continually.

On the 28th the sea remained perfectly calm arousing much profanity in the breast of a certain constructor, who was of the opinion that his own machines could pass the tests in a sea in which many of the other competitors could not. Moineau and Brégi on the 200-horse-power Canton-Unné Breguets, Renaux on the Renault Maurice Farman and Chemet on the 80-horse-power Gnome-Borel finished the preliminary tests.

Trouble arose from the owners of some of the machines entered in the competition owing to the fact that not only did Henri Farman, who was not competing, house his machine free of payment in an enclosure for which they themselves were charged $100, but that his numerous evolutions distracted the attention of the onlookers from the machines in the competition. No notice was taken of the latter complaint, but the machine was afterward stationed during the night on the beach, held down by ropes.

On the 29th four competitors started to compete in the competition proper, which consisted of a flight round a course ten nautical miles in length. Three different tests—speed, endurance and range of action—were to be passed, but these could be accomplished in one flight if desired. The speed test was held during the first ten laps.

The Lévêque, piloted by Molla, was the first to depart on this test, carrying fuel for 5½ hours. The first 100 miles were covered in 2 hours 6 minutes, the machine, meanwhile, emanating a strange and diverting moan, presumably with intention.

Moineau and Brégi subsequently took flight, the latter making slightly slower time than the former. Gaston Caudron and Chemet then started, while Levasseur attempted to pass the tests he had omitted during the previous days, but was unable to rise from the water. Weymann passed the altitude and *décollage* tests, and finished his preliminary tests. Janoir, finding himself unable to bring about any good results on his Deperdussin, contented himself with carrying passengers. Those qualified for the final tests were thus: Renaux, Gaubert, Weymann, Moineau, Brégi, Prévost, Chemet, and Molla.

Several of these had been already passed by several competitors, as will be seen from the following:

The Lévêque, piloted by Molla, accomplished 100 miles (nautical) in 2 hours 5 minutes 59$\frac{2}{5}$ seconds, the 180 nautical miles in 4 hours 6 minutes 39 seconds, the 250 nautical miles in 5 hours 24 minutes 14$\frac{4}{5}$ seconds. He had descended to the water after covering over 240 miles, though he had by that time set up a record for duration on a hydroplane. The Breguet, piloted by Moineau, covered 100 miles in 1 hour 51 minutes 4$\frac{4}{5}$ seconds, and 180 miles in 3 hours 21 minutes 33 seconds. He alighted after traversing 207 miles.

The Breguet, piloted by Brégi, covered 100 miles in 1 hour 57 minutes 13$\frac{1}{5}$ seconds. He alighted after having flown for 2 hours 20 minutes. The Borel, piloted by Chemet, covered 100 miles in 2 hours 2 minutes 30 seconds. He alighted after traversing 161 miles.

After several attempts Prévost succeeded in rising from the water, and covered 100 nautical miles in 1 hour 48 minutes 20$\frac{3}{5}$ seconds.

Renaux and Gaubert, on the two Maurice Farmans, effected their long distance runs with the following results—Renaux: 100 miles in 2 hours 13 minutes 30$\frac{2}{5}$ seconds; 250 miles in 5 hours 27 minutes 38$\frac{1}{5}$ seconds; 300 miles in 6 hours 40 minutes 25 seconds. Gaubert: 100 miles 2 hours 17 minutes 23 seconds; 250 miles in 5 hours 36 minutes 3$\frac{3}{5}$ seconds.

Levasseur on the Nieuport attempted to finish his eliminating tests, but was obliged to alight after half an hour's flight through magneto trouble. He therefore was excluded from participating in the competition proper.

Only the following pilots therefore remained to take part in the final tests: Renaux (M. Farman, No. 1), Gaubert (M. Farman, No. 2), Weymann (Nieuport, No. 3), Moineau (Breguet, No. 8), Brégi (Breguet, No. 9), Prévost (Deperdussin, No. 10), Chemet (Borel, No. 12), Molla (Lévêque, No. 15).

At mid-day Weymann attempted to start on one of the final tests. When rising from the water (which he did with some difficulty), the machine left the surface and promptly struck it again nose first. The pilot was rescued without injury, though the machine retired from the contest.

On the 31st, the last day, the sea was rougher than it had been on any of the previous days, and the destroyers, which had been on the scene of operations each day up till now, remained in harbor until the wind had abated somewhat. Prévost on the Deperdussin was the victim of a minor accident which occurred obviously as a result of the stormy conditions, his float struts giving way to the tremendous shocks brought about by the force of the waves on his unsprung floats. The machine sunk to below the surface of the sea, and only the floats were seen above it.

The final classification was as follows:

Speed over 100 nautical miles ($2,000 prize)—

(1) Moineau on Breguet, 200 horse-power Canton-Unné, in 1 hour 51 minutes 4$\frac{4}{5}$ seconds.

(2) Chemet on Borel, 80 horse-power Gnome.

(3) Molla on Lévêque, 120 horse-power Canton-Unné, in 2 hours 5 minutes 59$\frac{2}{5}$ seconds.

Mean speed over a course of 250 miles ($3,000 prize)—

(1) Molla, in 5 hours 24 minutes 14$\frac{4}{5}$ seconds.

(2) Renaux on Maurice Farman, 120 horse-power Renault, in 5 hours 27 minutes 38$\frac{1}{5}$ seconds.

(3) Gaubert on Maurice Farman, 120 horse-power Canton-Unné, in 5 hours 36 minutes 3$\frac{3}{5}$ seconds.

Test of endurance ($5,000 prize)—

(1) Renaux. *Ex aequo* Gaubert.

Tests reserved for "amphibians" ($1,200 prize)—

(1) Gaston Caudron on Caudron biplane, 100 horse-power Anzani, arose from the ground within 33 meters.

* Reproduced from *Aeronautics*.

Etanchiété: watertightness of floats. *Mouillage:* mooring.

The Manufacture of Swedish Filter Paper

Efficiency Obtained in Machine-Made and Hand-Made Processes

By Gustaf Fornstedt

There are many different qualities of filter paper, depending upon the use for which they are intended, and they range from an ordinary filtering paper for household use to the fine double-extracted, ashless filter paper intended for very particular analytical work. As a rule, the ordinary qualities are machine-made, while, on the other hand, the finer qualities are hand-made.

Machine-made filter paper includes, among other varieties, beer filtering paper, a paper of about 180 pounds weight, made chiefly from cotton rags, and used for filtering beer, as well as for the ordinary filtration of water. The paper is cut square and has 1½-inch round holes perforated in each angle for the insertion of four metal bars on which the paper, alternating with perforated zinc plates, is threaded and screwed firmly together. Through these layers of paper and zinc the beer or other liquid is passed at a pressure of about 0.6 atmosphere; the dirt and impurities remain on the paper and the clean and clear liquid passes through.

Machine-made filter paper is used chiefly in the household and for technical purposes, while hand-made filter paper for scientific analyses is of better quality, though of different grades and make, according to the character of the analysis to be made. The paper being more or less quick filtering, it is made with regard to whether a mere purification of the liquid is intended or whether the substances collected on the paper are to be qualitatively or quantitatively determined.

Some qualities of filter paper, as white and gray woollen paper, are made generally in small paper mills which are not equipped with steam boilers. The rag is furnished "raw" in the beaters and beaten free, but care is taken to avoid lumps. The paper is made on a cylinder machine and taken wet on the hasp, from where it is cut by hand and hung up for drying. A rough mottled surface is produced by means of a coarse wire cylinder running on the wet paper web, the impression remaining very plainly after the paper is air dried.

The cleanest rag is, of course, used as material for filter paper, and it must be of the best quality and sorted with great care. It is important to pick out buttons and any pieces of metal that may be carried by the rags. In new cuttings from shirt and collar factories, used in the finest qualities, stray pins and needles give rise to much work and trouble. Iron is, of course, one of the worst impurities in a filtering paper.

The rag is boiled with sodium hydroxide (NaOH), because it gives a lower percentage of ash than lime, and for the same reason the old method of bleaching the halfstuff with chlorine is preferred to the use of chloride of lime in bleaching hollanders.

For chlorine bleaching a mixture of manganese, salt, and sulphuric acid is used in leaden retorts in about the following proportions:

	Parts.
Binoxide of manganese	8
Sodium chloride	6
Sulphuric acid	5

Usually, however, a greater quantity of salt is used, because it contains a considerable amount of water.

After the rag is boiled, washed and beaten to halfstuff, it is dried in a centrifugal dryer and spread in layers on wooden poles in the bleaching chamber. This chamber is of concrete, lined with wood. After the bleaching chamber is filled with halfstuff the door is closed and chlorine admitted through an aperture in the roof. After all air has been withdrawn from the chamber it is well sealed, and the halfstuff, after absorbing the chlorine for several hours, is effectively bleached. Of late, in some mills this bleaching process has been considerably simplified. Liquefied chlorine pressed in steel bombs is used. The bomb is placed in hot water on a scale, a valve on top of the bomb, connected to the bleaching chamber with a rubber hose, is opened, and a certain amount of the liquefied chlorine makes its escape in the gaseous form and is so forced into the bleaching chamber.

The analysis of boiled and bleached halfstuff shows the following ash percentage (silica and lime):

New shirt cuttings, No. 1	0.039
Old linen white	0.132
Old linen, gray	0.140
Colored cottons	0.177
White cottons	0.107
Sulphite, bleached	0.298
Soda, bleached	0.4

It is, of course, a matter of great importance that the water used in the manufacture of filter paper should be as pure as possible, but it is impossible to avoid some ash-containing matter from being introduced to the halfstuff with the water of manufacture, and in the transportation of the halfstuff and the process of drying. Generally the increase is from 0.02 to 0.05 per cent, depending on the state of the weather and the condition of the water.

The time consumed in beating varies according to the nature of the material. Halfstuff freshly bleached requires longer time than that which has been stored some time. Neither too free nor too slow stuff should be used for filter paper. Stuff that is too slow retards filtration—meaning the time taken for a given quantity of water of a certain temperature to filter through a paper of specific diameter. Paper made of too free stuff fails to keep back the finer grained sediments, such as sulphate of barium, etc.

Among the considerations to keep in mind in the manufacture of filter paper are the rate of filtration demanded, the ash content, resistance to sulphate of barium, fine holes, weight, and impurities.

To produce a filter paper of low ash percentage requires treatment with hydrochloric or hydrofluoric acid or a mixture of these acids, which will remove impurities like ferric oxide, alumina, lime, magnesia, and silica, and paper so treated is practically a pure cellulose paper. With hydrofluoric acid silica is removed, and with hydrochloric acid the other substances enumerated are dissolved away. After treatment with acids the paper should be thoroughly washed with distilled water, to remove the last traces of acidity.

To test the neutral reaction of the paper after washing, a solution of nitrate of silver is used to advantage. The wet paper is squeezed with the hand over a glass funnel and the water filtered into a test-tube. In another test-tube containing distilled water a few drops of test solution of nitrate of silver are added, and the same quantity is added to the water expressed from the washed filter paper. The two tubes are then compared against a black background. If not neutral, the water from the filter paper will show an opalescence due to the formation of insoluble chloride of silver from the chlorides remaining in the paper, and further washing is necessary. After this treatment the paper is pressed and hung out in open barns in order to freeze it.

By freezing the paper is made soft and porous, since the ice crystals formed in it serve to drive the fibers apart. Because of this the finest qualities of filter paper only can be made in the winter time in cold countries.

Experiments have been tried of subjecting paper that has been dried in a warm atmosphere to a subsequent freezing operation, in order to impart the desired softness and porosity, but it has been found that paper treated in this way does not become soft, and it never comes up to the standard of the best Swedish filter paper.

Extracted filter paper is practically ashless, the ashes amounting to about 0.015 per cent of the weight of paper, and is often negligible not being taken into account in quantitative analytical work.

The most careful, accurate work is necessary in any determination of the ash content of a paper. The instruments required consist of a spacious drying apparatus of copper, two exsiccators, one large and one small, a platinum crucible (about 0.7 ounce) with cover, a stand, a spirit lamp, a blast lamp or Bunsen burner, and a particularly exact balance scale.

The larger exsiccator is used for the dry paper and the smaller for the platinum crucible. Every time the crucible is used it must be cleansed with the finest sand, which has been previously boiled in diluted hydrochloric acid, dried, fired, and kept in the exsiccator until the next time it is used. The scale placed on a table fixed to the wall ought to be of superior construction for fine analytical determinations. Soot must naturally be guarded against in the incinerating operation, as the particles would lead to error in the weighing and conduce to an early deterioration of the crucible.

The manipulations are as follows: The sample is first dried in the drying apparatus at a heat of 190 to 210 deg. Fahr. It is then transferred to the exsiccator for fifteen minutes, and afterwards cut in small pieces and put in the cleaned and weighed crucible. The crucible is supported on its stand and the cover adjusted so that air may enter. The crucible is first heated red hot, at which point the hydrocarbon volatilizes; the heat is then increased for twenty minutes, until the crucible glows white hot. After the ash turns white or gray-white the crucible is placed in the exsiccator for ten minutes and weighed; the incineration is then continued until a constant weight is obtained.

If the crucible weighs *a* gramme, the crucible and paper *b* gramme, and crucible and ash *c* gramme, the following formula is obtained.

Paper and crucible	$= b$ gramme
Crucible	$= a$ gramme
Paper	$= (b-a)$ gramme

Hand Brace.

a gramme

Ash and crucible	$= c$ gramme
Crucible	$= a$ gramme
Ash	$= (c-a)$ gramme

Hand Brace.

b gramme

The following figures giving the analysis of ash from fine filter paper are of interest.

I. *Prof. V. Wich.*		II. *Prof. Brunner.*	
SiO_2	31.876	SiO_2	30.63
Al_2O_3	14.364	AlO_3	14.86
Fe_2O_3	9.357	$Fe_2O_3+P_2O_5$	5.08
P_2O_5	0.238	MnO	1.74
$MnO.Mn_2O_3$	7.637	MgO	7.84
MgO	11.301	CaO	26.28
CaO	21.381	Alkali	13.57
Alkali	2.162		
SO_3	1.684		100.000
	100.000		

The best filter paper is made in Gryeksbo, Sweden. In the work of manufacture through a long period of years a practical and effective method of extraction has been employed. Being the most northerly hand-paper mill in the world, there is a long, splendid winter which is favorable for freezing the paper. The water is clear as crystal and practically chemically pure, having its origin in the Delecaalian Mountains. Berzelius, the world renowned chemist, esteemed the Swedish filter paper to be the best in the world, and the mill still maintains its reputation, the paper being in demand over all the old and new world, while the United States takes the bulk of it.

The paper is stamped out in different sizes from 5.5 centimeters to 18.5 centimeters, and is packed in birch-bark boxes, which are lined with thin sheets of zinc, hermetically sealed for export to foreign countries.

A good standard of the efficiency of a paper as a filtering medium is represented by the following factors: with a paper having a diameter of 6 inches, the maximum time for filtration of 6 cubic inches of water at 90 deg. Fahr. should be 140 seconds, the minimum time 90 seconds.—*Chemical Engineer.*

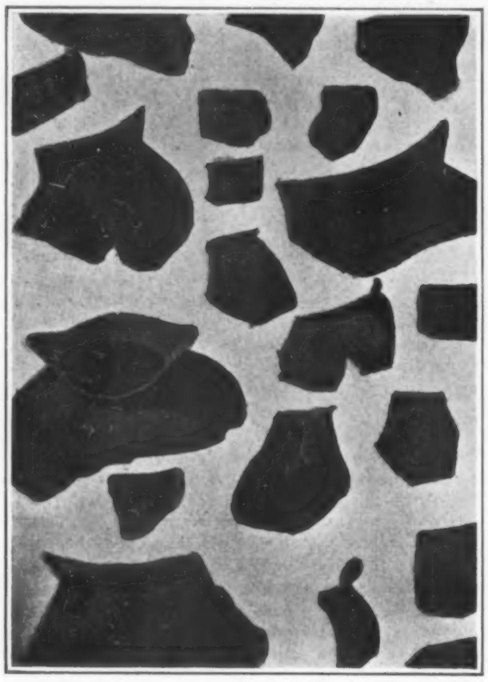
Wanted: New Uses for Bromine

A prize of $2,500 is offered by the Deutsche Bromkonvention G. m. b. H., Leopoldshall-Stassfurt, Germany, to the discoverer of a process or compound leading to a new or an increased consumption of bromine. The following are some of the conditions attached to this competition: The new discovery must represent a technical innovation and must not adversely affect existing uses of bromine. The process must be applied in practice at the latest one year after the awarding of the prize. The process must, in the opinion of the jury, lead to a considerable increase in the European consumption of bromine at a suitable price. Competitors must send in their processes by January 1, 1914, at the latest.—*The Journal of Industrial and Engineering Chemistry.*

Some Innovations in the Paper Industry

Philip B. Sadtler, of the Swenson Evaporator Company, of Chicago, Ill., has pointed out that by employing a battery of blow tanks to systematically wash the liquor out of the pulp, this may be accomplished with the least expenditure of water and the highest cleansing effect. This is, moreover, said to be one of the best methods for eliminating the objectionable odor of the sulfate pulp mill. Pulp is blown under pressure from the digesters directly into the blow tanks, the battery being used in countercurrent system for washing. The small expenditure of water leaves a minimum of water to be evaporated.

An idea which Mr. Sadtler has included in the design of the apparatus in the Chesapeake Pulp and Paper Company, at West Point, Va., is the use of waste heat gases from the rotary black ash furnaces to produce the generation of steam in the boiler; this steam is then used to carry out the evaporation of the black liquor in the evaporator. This idea of employing waste heat from special furnaces to generate steam in boilers is a novelty, it is said, in the pulp field.—*The Journal of Industrial and Engineering Chemistry.*

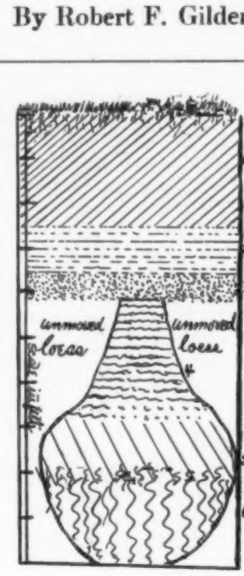


Potsherds from house ruins, showing a number of domestic implements.

A Prehistoric Dwelling in Nebraska*

A Cannibal Charnel House Unearthed

By Robert F. Gilder



Sectional view cache No. 3, cannibal house.

1, accreted soil; 2, roof material; 3, house floor; 4, cache filling (mostly clay); 5, fractured skull and other bones and wood ashes; 6, wood ashes, bone and stone implements.

Potsherds from house ruins, showing lugs, designs and contours.

In an address welcoming delegates of the Mississippi Valley Historical Association to Omaha May 8th this year, Col. John Lee Webster, president of the Nebraska Historical Society, made the first public announcement that the so-called "buffalo-wallow" type of aboriginal house ruin in Sarpy, Douglas and Washington counties, Nebraska, is in reality rectangular and that their circular or ovoid appearance is entirely due to weathering.

The credit of establishing this fact belongs to Mr. F. H. Sterns, a member of the Peabody Museum Staff, Harvard University, who made that and other important archæological discoveries during his season's work in 1912 in this vicinity.

Devoting his entire attention to exploration, Mr. Sterns was able to perform an amount of excavation which, so far as I have learned, is unprecedented in extent by one man. Selecting two ruins of a surface diameter of approximately 45 feet each, he removed all of the earth down to below the house floor and, when caches were encountered, to several feet deeper. In other words, he carried entirely across the ruin a ditch greater in length than the diameter of the ruin. His field notes, maps, reports, measurements, photographs, drawings, etc., are more accurate and detailed than any which have heretofore come under my notice. From time to time, when opportunity offered, I visited Mr. Sterns's work and was much pleased with his method.

After Mr. Sterns's discovery that the ruins had earth walls 4 feet high or deep, and that the houses were rectangular, confirmation of these facts was made by me while working over three old ruins. In one of these, two caches let into the side walls horizontally at a level with the house floor and the house corners were observed. Such is the character of the walls that their line is easily distinguished, in most cases it having been hardened by fire action.

Determination of rectangular houses compels the conclusion of gable roofs instead of the dome-shaped earth lodges erected by all the sedentary Missouri and Platte River tribes.

A new feature was introduced into my field of labor in Nebraska by the discovery a year ago of a veritable charnel house in Sarpy county, showing strong evidences of cannibalism. In June, 1912, I explored a small ruin and on its floor were charred human bones many of which had been mashed, and near a large flat boulder, southwest of the fireplace in the center of the ruin, were many bone fragments. Beside the rock was an unshaped hammer stone which bore evidence of much use. My conclusions were that the bones had been broken for their marrow. Quite a number of fine bone and stone implements were secured from the ruin and the quality of the pottery was excellent, not differing from pottery found in neighboring ruins. A clay pipe embellished with two engravings of primitive man's conception of a soaring bird, looking not at all unlike the "glider" first built by the Wright brothers, indicated that the primitive artist and the highly developed Wrights had conceived their idea of a soaring bird from the same model, although hundreds of years separated in time.

Three deep caches were located beneath the house floor, all of them containing human bones together with objects of domestic use, all evidently having been deposited and carefully covered with preserving wood ashes. One cache in particular was filled with human bones and the "plant" seemed to indicate they had been deposited when covered with flesh. Seventeen frontal bones indicated that numbers of persons had been victims of cannibals. Most of the skulls were of women and children. Nearly all the bones in caches and on the floor were more or less burned and blackened by fire and reposing within a fractured pot were several rib pieces which had attained the color of bones after boiling.

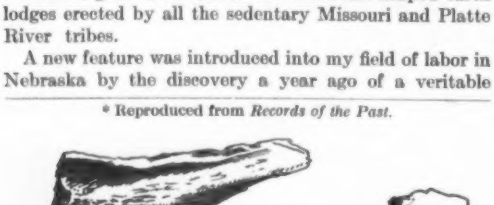
Assisting in the work of exploration of the "cannibal" house at times were Mr. Roland B. Watson and Mr. F. H. Sterns, the last mentioned acting as photographer, making plates of material in place, and when the camera could not be used I made pencil sketches. The whole work was conducted with extreme care and the impression of all the excavators was that the evidences of cannibalism were exceptionally strong. All the material from this ruin with the exception of a soapstone pipe, the clay pipe heretofore described and one scapula implement is now in the Peabody Museum, Harvard University.

In nearly all of the thirty-two house ruins I have examined I have found pieces of human skulls and other human bones, but never indicating that cannibalism was practised.

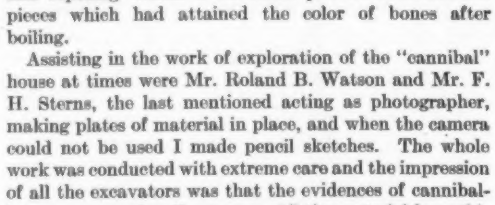
When the Mississippi Valley Historical Association had completed its annual meeting in Omaha this year (1913), accompanied by Dr. Orin G. Libby of the University of North Dakota, who is secretary of the North Dakota Historical Society, and who has done a large amount of work in the Mandan, Hidatsa and Arakara Indian villages on the Missouri River in that State and who has also been studying the ethnology of the remnants of those tribes near Elbowoods, N. D., for many years, I visited the scene of my archæological labors in Sarpy county. Dr. Libby was greatly interested with the type of ruin found there and at first view he was inclined to consider them similar to Hidatsa ruins in North Dakota, but after careful examination he became convinced they were not like ruins in any of the ancient villages he had seen. The Sarpy county ruins are in no wise in village formation, a fact which puzzled Dr. Libby not a little, but he stated that any one of the larger Sarpy county ruins could easily have housed 200 souls, basing his statement on his knowledge of the population of the North Dakota aboriginal villages. The Hidatsa ruins, according to Dr. Libby, are probably as deep as some of the Nebraska type, but were not of similar shape and were certainly ovoid and not rectangular. Then, too, after careful examination of pottery taken from the Nebraska ruins, Dr. Libby stated emphatically that it in no wise resembled pottery from any North Dakota village site, nor had he seen similar decorations or contours in his State. In all we examined 40 ruins during our trip. The great size and present depth of the Sarpy county ruins was a cause of astonishment to the North Dakota scientist.

On looking over my collections Dr. Libby found several objects which he stated could be duplicated in the deserted villages of North Dakota, notably the comb made from antler and one large bone fishhook, but most of the other objects were unlike artifacts from North State abandoned villages.

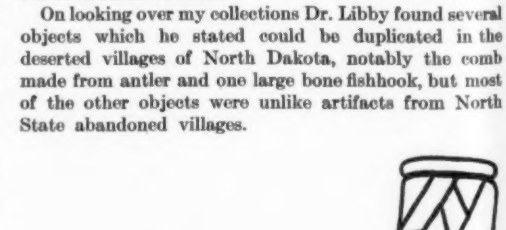
* Reproduced from *Records of the Past.*



Fractured mammal bones from cache in nearby ruin.



Fractured human bones from cache No. 3.



Showing conventional design of soaring bird.

The Circulation of Sap in Trees

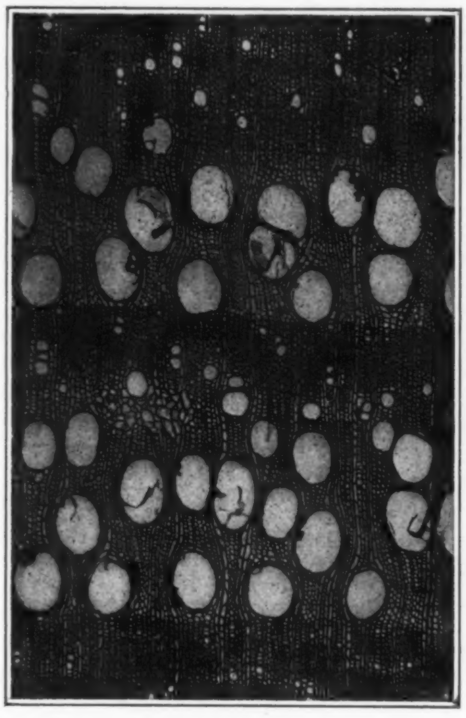
The Factors Causing Movements of Sap Are Not Yet Admitted By All Botanists

The woody portion of a tree is made up of fine wood fibers and vessels. The latter extend from the roots to the leaves, and it is through these vessels or pores that the sap is conducted. If a young, thrifty growing tree is pulled up by the roots, and the roots are placed in a vessel containing some highly colored anilin solution which they will absorb, the course of this colored solution can be easily traced through the tree by cutting notches into it at successive periods. The coloring matter first permeates the body of the wood near the root, then in the wood higher up the stem, and so on until it reaches the leaves. The dye next begins to appear in the inner bark of the twigs and passes down through the bark again to the root. This observation shows that the sap first circulates up through the outer, lighter colored wood, and then down through the inner or living bark.

Much has been written concerning the factors which cause the sap of trees to circulate, but it has never been completely settled to the satisfaction of all botanists. Sap circulates during the winter, though less rapidly than during the summer, and less rapidly at that time in deciduous than in evergreen trees. The thin, green barks on the one and two year twigs function in exactly the same manner as do the leaves in summer.

Thoroughly dried wood is composed mainly of water and charcoal. When the charcoal is burned the volatile gases are driven off and there is left a small portion of ash which is the mineral or inorganic matter found in wood. It consists principally of potash, lime, and silica. In burning charcoal the carbon, which is the portion that burns, unites with oxygen of the air to form carbonic acid gas. The water and the inorganic substances enter the tree through the roots while most of the carbon enters through the leaves. Carbon forms about one half of the solid substance of the tree and water the other half.

Water is composed of hydrogen and oxygen in the proportion of one to eight and these elements enter into chemical combination with carbon, lose the liquid state of water, and form the various solid substances which make up the woody portions of the tree. The sap undergoes important chemical changes in its course up and down the tree, one of these being the decomposition of carbonic acid in the leaves. The affinity of carbon and oxygen is very strong, but the combined action of sunlight



Cross section of the wood of the Chestnut (*Castonea dentata*) magnified 50 diameters. The large open pores are the vessels which extend up and down the tree and conduct the sap. The smaller elements are the wood fibers.

and green coloring matter, called chlorophyl, separate them in the leaves and green bark of young twigs. Carbonic acid gas is absorbed by the leaf from the atmosphere. The two elements are disassociated, the oxygen is returned to the air, and the carbon combining chemically with other elements in the sap is carried to wood-forming tissue, where it is deposited to help build up the cell walls in the wood. The symmetrical order in which the cells are arranged in a tree may be seen in the accompanying reproduced photograph of a microscopic section of chestnut wood.

If wood is examined under a microscope, it is found that the vessels which conduct the sap are made up of numerous minute segments or cells open at both ends, thus forming a continuous passage. The bulk of the wood mass is composed of wood fibers or short spindle-shaped elements which serve as a mechanical support for the tree. The substance of which the walls of these cell elements are formed, and which is so extensively used in paper making is called cellulose. It consists of carbon, oxygen and hydrogen. Each atom of cellulose contains twelve atoms of carbon, ten atoms of hydrogen, and ten of oxygen, giving the formula $C_{12}\ H_{10}\ O_{10}$. Starch, gum, and sugar have the same composition, $C_{12}\ H_{10}\ O_{10}$. It seems peculiar that substances composed of the same elements and combined in the same proportion, should have properties so widely different as gum, starch, sugar, and cotton. Their different properties, however, are the result of the different modes in which the atoms are arranged or grouped.

Besides the substances already mentioned, there is another called lignin, which constitutes a considerable portion of wood. It is also formed of the same elements as cellulose, but in slightly different proportions, its formula being $C_{12}\ H_8\ O_5$. It is a deposit or infiltration on the inner surfaces of the cell walls, and its chief use is for strengthening and stiffening these walls.

If the wood is thoroughly dried so as to drive off all water, nine tenths of the remaining substance consists of the five compounds, lignin, cellulose, starch, gum and water, all of these being composed of hydrogen and oxygen in the same relative proportions as that in which they exist in water, chemically combined with carbon. It remains to be determined why the atoms of these substances are so arranged in one part of the plant to form cellulose, in another starch, or in another tree to form gum or sugar.

The Demonstration of Mining Plans

A Ready Means of Ascertaining Information at a Glance

By H. G. Henderson

It is a somewhat unfortunate fact that the directors of a mining company are very often unable to comprehend the mining plan. Sections they do understand, but they and even many mine managers are more or less lost when plans of the underground workings are set before them. The ordinary mine plan, except to the expert, seems very much like a patchwork quilt, with neither order, method nor connection, and as a result of this inability to comprehend the plans quickly, the economical conduct of a mine is often in consequence sadly interfered with. The writer, having this point in mind, some few years ago designed a method, by means of which the plans of underground workings can be clearly and simply demonstrated even to those who are not particularly conversant with the points involved.

In this method a tracing is first carefully made of the mine plan on good tracing paper and is then colored in the usual way. With a sharp pair of scissors each level is then cut out. Another tracing is then made of the mine plan and placed face downwards on a sheet of white paper. A sheet of transparent celluloid is then taken and laid down on the inverted tracing, and the uppermost level which has been cut out is attached with clear gum to the celluloid in the exact position indicated by the inverted tracing below. It is evident that when the celluloid sheet is reversed the level will then appear in its proper position. Each level is then treated in the same way, and subsequently each sheet of celluloid is framed. These frames are then superimposed upon one another in their proper order and hinged together. Fig. 1 shows a single framed section with one of the levels indicated upon it by the method given above; while Fig. 2 shows a complete collection of levels. The object in fixing the cut out levels to the underside of the celluloid sheets is two-fold. In the first place the gummed on levels are less subject to injury due to dust. In the second place the width of the lode and its assay value can be written down in blue water proof ink on the upper surface of the celluloid together with any remarks, dates, references, letters or figures, and these can be removed at any time by means of a wet cloth without harming the level underneath.

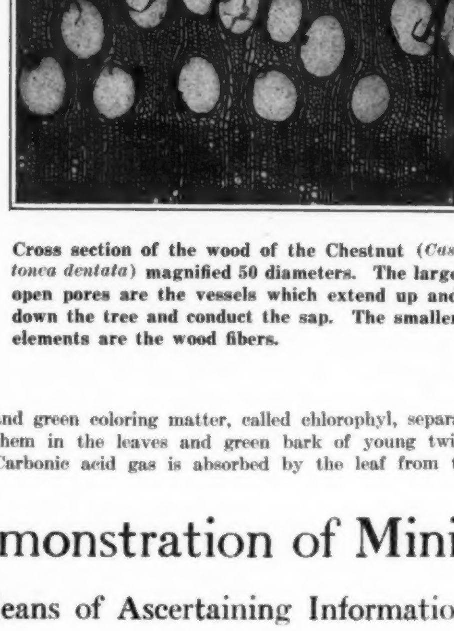


Fig. 1.—Framed section showing a single level.

The advantages of such a model are obvious. If, for example, such models were sent in with the manager's monthly reports, the directors of the mine would be able to obtain a most intelligent grasp of the progress of operations, and no doubt this would add to the beneficial conduct of the mine. Moreover, not only can the mine as a whole be seen at a glance, but each level can be separately referred to and every point mentioned in the manager's report can be fully comprehended. A third advantage is that the separate levels are not mixed together as often is the case in the eyes of the uninitiated, on an ordinary mine plan. The property of depth in this connection makes the construction of such a model a most valuable piece of work, and can be recommended to mining surveyors who have not already some such system in operation.

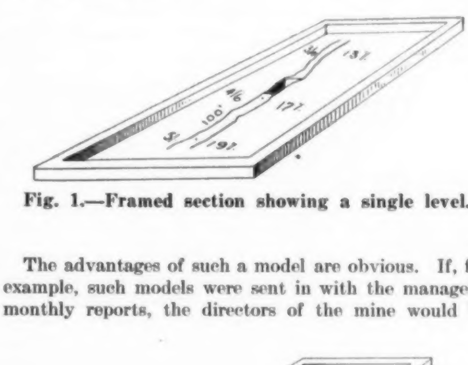


Fig. 2.—A complete collection of levels.

The Consumption of Thorium in the United States

It is noted in the *Chemiker-Zeitung*, 37, No. 77, 776, that the only company in the United States which produces thorium compounds from monazite sand is the Welsbach Company, of Gloucester City, N. J., although there are two or three other companies which obtain thoria from waste Welsbach mantles. The mining of the monazite deposits in the Carolinas, which supplied 1½ million pounds in 1912, has been discontinued, owing to the decrease in the import tax from 6 cents to 4 cents per pound. The number of gas mantle factories has diminished from 89, in 1909, to 50, the most of which are found in the States of Ohio, New York, Pennsylvania, and Illinois. In all, 65 million mantles are manufactured per year, of which 40 per cent are made by the Welsbach Company. The consumption of thorium compounds for this purpose amounts to about 220,000 pounds, more than half of which is imported from Germany. The duty on thorium salts, gas mantles and spent mantles is 40 per cent of their value. According to a report made by the General Gas Mantle Company, of Camden, N. J., the cost of 1,000 incandescent gas mantles is $42.07 in New York, and the German manufacturers can sell the same for $42.50, including the import tax.—*The Journal of Industrial and Engineering Chemistry.*

Letters Patent in Relation to Modern Industrial Conditions—II*

Adequate Patent Protection an Absolute Necessity for Progress

By Frederick P. Fish

Concluded from SCIENTIFIC AMERICAN SUPPLEMENT No. 1969, Page 203, September 27, 1913

It is interesting to note the increase in the number of letters patent that have been issued in the United States during the forty or fifty years of our recent marked industrial development.

INDUSTRIAL DEVELOPMENT UNDER THE AMERICAN PATENT SYSTEM.

Up to the close of the year 1870 there had been taken out in the United States, from the beginning, 120,573 patents; from the beginning of 1871 to the end of 1911 there were issued 1,002,478 patents. In the year 1900 there were 41,980 applications for letters patent filed in the Patent Office. There were 54,971 in 1905; 64,629 in 1910 and 70,976 in 1912; in 1850 the number of patents issued by the United States Patent Office was 993; in 1860 it was 4,778; in 1880, 13,947; in 1900, 26,499 and in 1910, 35,930.

The number of patents issued in the United States as compared with those issued in the rest of the civilized world is shown by table No. 2.

TABLE No. 2	To 1870 Inclusive.	From 1870 to 1911.	Total.
United States	120,573	1,002,478	1,123,051
France	103,934	336,964	440,898
Great Britain	53,408	371,966	425,374
Germany	9,996	238,110	248,106
Belgium	35,044	202,456	237,500
Canada	4,081	129,609	133,690
Italy and Sardinia	4,723	94,175	98,898
Austria	......	64,793	64,793
Switzerland	......	50,197	50,197
Spain	......	44,987	44,987
Sweden	1,629	31,734	33,363
Russia	1,464	23,528	24,992

It is clearly far more than a coincidence that the number of patents issued has so largely increased simultaneously with the most extraordinary development in manufactures that the world has ever seen. There are undoubtedly other contributing causes, but the great number of new things designed and perfected and the vast improvements in methods and machinery and quality of product which are reflected in the million patents issued in the United States since 1870 are certainly a prime cause of our progress in the industries. A few figures are significant.

In 1850 the manufactures of every kind in the United States amounted to $1,019,106,616. In 1880 they had increased only to $5,369,579,191. In 1910 they had attained the enormous total of $20,672,051,870, an amount equal to one fifth of all the wealth of the United States, six times the total money in circulation, nine times the total gold and silver in circulation, twelve times the total domestic exports, thirteen times the total imports, twenty times as much as what would be required to pay the national debt, and two hundred and sixteen times the value of all the gold produced in the United States.

This increase has not, even in recent years, been only in large individual enterprises. Between 1905 and 1910 the number of establishments engaged in manufacture increased nearly 25 per cent, from 216,180 to 268,491.

During the same period the number of employees increased nearly 24 per cent, from 5,987,939 to 7,405,313. The wages of employees increased from $3,184,884,275 in 1905 to $4,365,612,851 in 1910, nearly 38 per cent.

The amount of wages paid in manufacturing industries in the United States in 1910 amounted to nearly two thirds of the total wealth of the United States in 1850, nearly one and a half times the total money in circulation in 1910, nearly twice the amount of wages paid out in 1900, over two and a half times the amount of exports and nearly three times the amount of imports in 1910, four times as much as would be required to pay the national debt, four and a half times the amount of wages paid out in 1880, eighteen times the total wages paid out in 1850 and seventy times the total amount of money coined in 1911.

Table No. 1 illustrates the more recent progress in a few of our industries, in which invention has played a conspicuous part, either because they were themselves new or because there have been such revolutionary improvements in the machinery and methods employed in them as to give them new life:

TABLE No. 1	1899	1904	Per Cent Increase.	1909	Per Cent Increase.
Agricultural Implements	$101,207,000	$112,007,000	10.7	$146,329,000	30.6
Automobiles	4,748,000	30,034,000	532.6	249,202,000	729.7
Bags, Paper	6,799,000	10,087,000	48.4	15,698,000	55.6
Boots and Shoes	290,047,000	357,688,000	23.3	512,798,000	43.4
Cars	9,371,000	13,437,000	43.4	31,963,000	137.9
Cash Register and Calculating Machines	5,675,000	9,875,000	74.0	23,708,000	140.1
Chemicals	62,637,000	75,222,000	20.1	117,689,000	56.5
Electrical Machinery and Supplies	92,434,000	140,809,000	52.3	221,309,000	57.2
Fertilizers	44,657,000	56,541,000	26.6	103,960,000	83.9
Food Preparations	39,837,000	61,180,000	53.6	125,331,000	104.9
Optical Goods	5,221,000	6,117,000	17.4	11,735,000	91.8
Paper and Wood Pulp	127,326,000	188,715,000	48.2	267,657,000	41.8
Paper Goods	24,355,000	33,946,000	39.4	55,171,000	62.5
Pens, Fountain and Gold	1,706,000	2,774,000	62.2	4,739,000	70.8
Petroleum, Refined Products	123,929,000	175,005,000	41.2	236,998,000	35.4
Phonographs	2,246,000	10,237,000	355.8	11,726,000	14.5
Photographic Apparatus and Materials	7,779,000	13,023,000	67.0	22,561,000	73.2
Photo-Engraving	4,190,000	7,268,000	73.5	11,624,000	59.9
Printing and Publishing	395,187,000	552,473,000	39.8	737,876,000	33.6
Pumps	1,342,000	2,853,000	112.6	5,583,000	95.2
Rubber Goods	52,622,000	62,996,000	19.7	128,436,000	103.9
Typewriters and Supplies	6,932,000	10,640,000	53.5	19,719,000	85.3
Wire	9,421,000	37,914,000	302.4	84,486,000	122.8

Our foreign trade in manufactured goods, which depends so largely upon the soundness of our industrial development and our relative advantages in machinery and processes of manufacture, is greatly increasing in industries which have particularly profited by invention, as is shown by table No. 3.

The figures given in the tables named only touch the situation. In an infinite number of other industries there has been a like marked development traceable directly to the fact that invention has been promoted and inventors and capitalists stimulated by our patent system to make and introduce improvements. The gain because of invention would appear even more clearly if there were space for the figures of earlier years.

For example, in 1880, the product of agricultural implements was $68,640,846; of boots and shoes, $196,-920,481; of chemicals, $38,173,658; of electrical machinery only, $1,074,388; of fertilizers, $23,650,795; of paper and wood pulp, $57,008,364; of photographic apparatus and materials, $246,305.

The salaries and wages paid in manufacturing industries in 1880 were $947,953,395.

Our exports in 1880 in agricultural implements were $2,245,742; in chemicals, $2,756,469; in cotton manufactures, $9,981,418; in iron and steel manufactures $12,605,786; in rubber manufactures, $306,680. In manufactures of all kinds they were $121,818,298 as against $1,020,417,687 in 1912.

The increase since 1899 in the number of establishments and of persons employed, and in the capital invested and the salaries and wages paid in the above industries, is shown in table No. 4.

Moreover, manufacturing statistics, in and of themselves, do not begin to tell the whole story. Everywhere the community gets the benefit of the work of the inventors and of the capitalists who have aided them in the development of inventions. What would be the condition of our agriculture if it had not been for the invention of the wonderful agricultural machinery which alone makes it possible for us to prepare and care for the soil and plant and harvest our crops? Our apparatus for the development and transmission of power, our machinery, our great transportation systems, our roadbeds, steam and street cars and locomotives, our ships, and railroad and ship apparatus generally, not less than our horse-drawn vehicles and motor cars, depend for their perfection, comfort and safety upon an infinite number of patented inventions. Our present structural methods

TABLE No. 4

Year.	No. Estab.	Persons Engaged.	Capital.	Salaries and Wages.
AGRICULTURAL IMPLEMENTS.				
1899	....	....	$157,708,000	$30,814,000
1904	....	55,089	196,741,000	32,576,000
1909	640	60,229	256,281,000	38,749,000
AUTOMOBILES.				
1899	57	2,509	5,769,000	1,616,000
1904	178	13,333	23,084,000	8,416,000
1909	743	85,359	173,837,000	58,173,000
BAGS, PAPER.				
1899	....	2,329	6,917,000	997,000
1904	62	2,886	11,441,000	1,335,000
1909	74	3,683	10,780,000	2,020,000
BOOTS AND SHOES.				
1899	....	159,579	110,363,000	70,083,000
1904	1895	171,940	136,802,000	82,484,000
1909	1918	215,923	222,324,000	117,092,000
CARS.				
1899	....	7,226	10,782,000	4,599,000
1904	86	11,551	12,906,000	7,556,000
1909	541	23,699	38,899,000	15,690,000
CASH REGISTERS AND CALCULATING MACHINERY.				
1899	18	2,394	5,242,000	1,579,000
1904	32	5,012	7,588,000	3,551,000
1909	50	9,249	27,224,000	8,048,000
CHEMICALS.				
1899	....	21,143	89,069,000	12,316,000
1904	275	22,707	96,621,000	14,838,000
1909	349	27,791	155,144,000	20,222,000
ELECTRICAL MACHINERY AND SUPPLIES.				
1899	581	47,080	83,660,000	25,211,000
1904	784	71,485	174,066,000	42,933,000
1909	1009	105,600	267,844,000	69,574,000
FERTILIZERS.				
1899	....	13,293	60,686,000	6,310,000
1904	399	16,091	68,917,000	7,061,000
1909	550	21,950	121,537,000	11,883,000
FOOD PREPARATIONS.				
1899	645	9,752	21,401,000	4,594,000
1904	766	14,739	51,784,000	7,397,000
1909	1213	20,965	64,685,000	12,908,000
OPTICAL GOODS.				
1899	91	4,090	4,212,000	1,886,000
1904	122	4,724	5,381,000	2,350,000
1909	217	7,809	10,147,000	4,551,000
PAPER AND WOOD PULP.				
1899	....	52,581	167,508,000	25,247,000
1904	761	70,051	227,444,000	38,116,000
1909	777	81,473	409,348,000	50,315,000
PAPER GOODS.				
1899	246	10,319	18,152,000	5,000,000
1904	308	16,696	27,345,000	7,570,000
1909	403	22,385	48,662,000	11,870,000
PENS, FOUNTAIN AND GOLD.				
1899	45	842	1,087,000	519,000
1904	49	1,196	1,545,000	731,000
1909	65	1,820	3,121,000	1,266,000
PETROLEUM, REFINED PRODUCTS.				
1899	67	16,400	95,328,000	8,528,000
1904	98	18,768	136,281,000	12,713,000
1909	147	16,640	181,916,000	13,759,000
PHONOGRAPHS.				
1899	11	1,411	3,348,000	887,000
1904	14	3,940	8,741,000	1,350,000
1909	18	5,928	14,363,000	3,786,000
PHOTO-ENGRAVING.				
1899	203	3,175	1,994,000	2,200,000
1904	223	5,071	4,071,000	3,850,000
1909	313	7,277	5,474,000	7,599,000
PHOTOGRAPHIC APPARATUS AND SUPPLIES.				
1899	....	3,913	5,518,000	1,896,000
1904	....	5,041	7,720,000	2,905,000
1909	103	6,596	18,918,000	4,499,000
PRINTING AND PUBLISHING.				
1899	23,814	235,945	333,003,000	139,291,000
1904	27,793	316,047	432,854,000	194,944,000
1909	31,445	388,466	588,346,000	268,086,000
PUMPS.				
1899	....	727	1,261,000	331,000
1904	....	1,721	3,230,000	934,000
1909	102	2,623	6,018,000	1,678,000
TYPEWRITERS.				
1899	47	4,872	8,400,000	2,884,000
1904	66	7,509	16,642,000	4,715,000
1909	89	12,101	26,309,000	8,928,000
RUBBER GOODS.				
1899	....	22,229	39,302,000	10,298,000
1904	224	23,651	46,298,000	12,269,000
1909	227	31,284	98,507,000	19,526,000
WIRE.				
1899	....	1,697	4,242,000	996,000
1904	25	5,325	14,899,000	3,652,000
1909	56	19,945	60,157,000	12,515,000

TABLE No. 3	1901	1906	1911	1912
Agricultural Implements	$16,313,434	$24,554,427	$35,977,398	$35,640,000
Automobiles, Cars, Vehicles	10,920,931	17,788,425	30,534,936	42,633,303
Chemicals	14,866,035	19,155,989	23,077,414	25,117,217
Copper Manufactures	43,267,021	81,282,664	103,813,110	113,958,919
Cotton Manufactures	20,272,418	52,944,033	40,851,918	50,769,511
Fertilizers	5,425,960	8,686,965	10,721,132	10,873,908
Iron and Steel Manufactures	117,319,320	160,984,985	230,725,352	268,154,262
Paper Manufactures	10,911,244	15,375,517	19,215,499	19,458,050
Petroleum Refined Products	64,425,859	77,025,196	92,698,003	105,640,733
Photographic Goods	1,998,445	....	7,142,603	9,445,446
Rubber Manufactures	3,659,361	6,543,735	12,452,562	12,822,918
Silk Manufactures	244,678	595,124	1,538,543	1,992,765
Manufactures of all kinds	465,777,992	686,023,168	907,519,841	1,020,417,687

*Paper read before the American Bar Association at Montreal, on September 2nd, 1913.

are largely based upon patented ideas. Our methods of reducing ores, our processes for metal working, the equipment of our stores and offices, our elevators and our lighting, heating and sanitary conveniences are the result of a striking series of inventions. Our household utensils and domestic appliances, our furniture and our wearing apparel, reflect inventive ideas that are patented. Our laundries are filled with patented machinery.

PRESENT AND FUTURE NEED FOR ENGINEERING INVENTIONS.

Great as has been our accomplishment, even if the situation were normal and there were no new consideration affecting the question, it is clear that continued and incessant industrial improvement is essential to our well-being. In the practical arts there is no such thing as a stable condition that can be relied upon as permanently satisfactory. Unflagging invention is required at every stage of progress. What has been accomplished in the past is already absorbed and as it were, expended. Unless there is continued improvement the industries of a country will stagnate. If the time ever comes when those who can invent and those who can promote inventions conclude that there is no longer the prospect of adequate reward in the field of invention, industrial progress will cease and its cessation means a definite retrogression. Invention and a patent system that will stimulate invention are therefore required even if all other considerations are favorable.

But there are special reasons of a serious character why it is at the present time more necessary than ever before that the progress of invention and the promotion of the useful arts should be stimulated.

Up to a recent time our situation in all respects has been such as to promote industrial development. We have had as a background for it an enormous amount of free land which was open to cultivation. This has now been practically exhausted. This circumstance affects our industrial situation disadvantageously; but it had to come. We must use every weapon to neutralize the loss of this asset.

Again, up to recent years (to repeat in part what has already been said) public opinion, the trend of legislation and of the law and what seemed to be the settled ideas and principles of our social organization were distinctly favorable to our industries and conspired to promote them.

The relations between capital and labor were such that while the working-man received a larger return for his effort than came to him in any other part of the world, the margin of profit to the capitalist and manufacturer was such as to encourage him to strenuous efforts. We have had a public sentiment which crystalized on the proposition that nothing was so important as industrial prosperity and gladly gave what may now be regarded even as excessive encouragement to industrial effort: Law makers and the courts, publicists, newspapers and writers generally were all on the side of business expansion.

As a result of the conditions under which business was carried on, we developed men of the highest administrative capacity, who organized industries, opened and exploited new fields, trained labor and in every way enthusiastically promoted the expansion of industrial and commercial effort. These industrial leaders were admired and encouraged because of the extraordinary results of their efforts. If it had not been for this admiration and encouragement they would never have accomplished or undertaken to accomplish their great work. It was their pride of achievement and the consciousness that they were appreciated by the community, far more than the prospect of gain, that inspired them.

Such men are now the object of popular criticism and there can be no reasonable doubt that, because of such criticism, they are becoming disheartened to such an extent as to lose at least a part of their capacity for serving the community.

These conditions, so favorable to industrial growth, have largely disappeared. The prevailing popular sentiment of to-day and the new laws and new interpretation of old laws based upon that sentiment are such as to require a definite readjustment of business and of business methods in all their relations. It may well be that it is a social necessity that such a readjustment should take place, that the monopolistic tendencies of business and of business men should be restrained, and that industrial methods and practices should be reformed, whatever may be the consequences. It may be essential that individualism should be checked and society reorganized on a basis that will insure a different distribution of wealth and of the fruits of productive effort. With that end in view it may be that we should go still further with legislation which operated to reduce the productive capacity of labor, and should accept as proper the reduced efficiency arising from the principles of trade unionism. It may be that there should no longer be the element of protection in our tariff. It may be that distrust of business men and of business methods is a healthy sign of a sounder moral insight. It is not impossible that when we have lived through this era of change we shall be a stronger, better, happier and more prosperous community. But the process of readjustment will surely be one of shock to our industries. They will endure, even if they could never have grown to their present proportions had the ideas of to-day prevailed fifty years ago. It is, however, clearly a time in which we should hold on to any feature of our social organization that is right and honest and able to sustain our industries during a period of stress. It is no time to reduce the encouragement to invention afforded by our patent system. As far as the matter of increased returns to labor is concerned, it is absolutely clear that we have been able to progress to so great an extent in this direction only because of our inventions. They have reduced cost at least as rapidly as it has been increased by the higher wages and shorter hours of our workingmen.

DANGERS THAT ONLY PATENT PROTECTION CAN AVERT.

We must not forget that, from this time on, the question of foreign competition is sure to be more serious every year. To-day, except for the artificial protection of tariff laws, the whole world, because of improvements in transportation facilities due to invention, is in immediate competition. No industry can thrive in any country unless that country has peculiar advantages, either natural or acquired, so as to be able to produce at such low cost as to meet the competition of other countries in that industry. The natural advantages of the United States are great in some directions, but are by no means altogether controlling. In our competition with foreigners we are hampered in many ways. In our cost of production we are embarrassed by the high cost of our labor as compared with that of other countries; for there is no doubt whatever that, whether measured in money or in commodities, our wages, as we desire to have them, are higher than in any other country in the world and much higher than in many of the manufacturing countries which are our sharpest competitors. We have in the past more than held our own in international competition, partly because we have surpassed all other countries in shop and business organization, but chiefly because of our superiority as inventors and in the quick and comprehensive adoption of inventions.

While it is true that the rest of the world may and does take our inventions freely, as we may and do take theirs, foreign countries have been for the most part a long distance behind us in the adoption of new ideas and methods and we have been able to maintain our advantage by the rapidity with which, with us, improvements have succeeded each other. But if the process of continuous improvement is checked, we shall lose this advantage and there will be no alternative except the destruction of some or many of our most important industries or a reduction in the wages and standard of living of our workmen. It is clear that the latter would be most disastrous and might well lead not only to industrial but to social crises of a most disturbing character.

An important consideration, often overlooked, is that the opportunity for improvements based upon invention is in many branches of industry growing less every year. There is no longer room for the striking advances in agricultural machinery, machinery for making fabrics and shoes, electrical and other power apparatus and machinery employed in the production and working of wood and metals and in other great departments of industry that there was a few years ago. It may almost be said that many of the arts are already developed almost to the point of saturation. It is not so easy as it was to find out how they can be improved and to improve them. This does not mean that there is not opportunity even in such industries for an infinite number of relatively small improvements, and occasionally for a larger invention, which, if we can make them, will be of the greatest value in the increase of efficiency and economy and the improvement of quality. But the conditions are clearly such that it is of the utmost importance that there should be adquate encouragement to make these inventions, and particularly that there should be every possible incentive to seek out and to develop an incessant series of the minor improvements which may in the aggregate afford great possibilities of advancement. The latter are of a kind that especially requires encouragement, for they do not greatly appeal to the imagination and the direct returns from any one of them are not likely to be large. They are not often developed except by definite and strenuous work, intelligently applied. Close and careful study and scientific effort, carried on persistently, systematically and at great expense, are generally required.

There are of course some arts of great importance in which development has not much more than begun. There is no limit to the inventions that may be made in chemistry, where the scientific men are constantly revising their theories as the result of persistent study, and every revision of a theory may lead to new and most astonishing practical applications. It is not impossible that agriculture and the production of food products may be revolutionized during the coming century by chemical inventions. In other fields there is room for many great and important improvements, which cannot be realized unless our patent system affords the requisite encouragement.

There are other conditions and so-called "tendencies" of the times which surely operate to check industrial development, and may do so to a destructive extent. I call attention to a few only of them.

There can be no doubt that our present inordinate national, State and municipal expenditure, which is constantly increasing and which is largely borne by our industries, imposes on them a most serious burden and thereby hampers their sound development. Much of this expenditure is wasteful, much of it is unproductive, but there seems no hope that it will be checked. The present uncertainty as to our monetary, banking and currency system may continue for a long time. While it lasts, it depresses industry. Uncertainty as to the law and as to new legislation which may be passed affecting our commercial and industrial activities, seems likely to be a chronic evil for many years. It surely embarrasses and checks industrial enterprise. Individual extravagance is as marked as that of our governing bodies. From this our industries suffer. The inclination for amusement rather than for work, which seems to prevail as never before among all grades and classes of those who are engaged in industrial pursuits, must in the long run seriously affect their efficiency. It may well be that we are using up and perhaps wasting our natural resources to such an extent that in a comparatively short time our industries will suffer.

If such unstable conditions, affecting business at the present time, exist to anything like the extent which seems to me probable, it must be of vital importance that there should be no slackening of invention among our people. More than ever, when there are causes at work which depress enthusiasm and hold back development, should inventive effort be promoted and the inventive spirit fostered. It would seem to be no time for the suggestion of drastic changes in our patent laws by reason of which the encouragement to invent and to introduce inventions into use will be reduced. Even the threat of such changes is unfortunate and ill advised. The public interest surely requires that our people should more than ever be encouraged and stimulated to invent, as our chief basis for hope that we may maintain our industrial supremacy or anything like our present material prosperity.

THREATS AGAINST THE PATENT SYSTEM: THE OLDFIELD BILL.

I cannot help thinking that the Oldfield bill which has been reported by the Committee on Patents to the House of Representatives at Washington is a most serious attack upon our patent system. In the opinion of the writer it does not at all meet any evils of the present patent law, if there are such, but, on the contrary, its provisions are almost without exception definitely harmful. If it became law, the bill would surely discourage invention and the promotion of inventions to a marked degree, with no compensating advantages. Those of its provisions, Sections 4, 5, 6, 7, 8, 9, 10, 11 and 12, which purport to develop the underlying principles of the Sherman Anti-Trust law into a long series of drastic restrictions and negations, aimed only at patent owners and those who manufacture under patents, should clearly not appear in a bill dealing with the patent laws. If any of the provisions of those sections are wise for any purpose they should be adopted as part of a revision of the Anti-Trust Law and not of the Patent Law. In the effort to put them on the statute book they should be discussed as relating to the alleged necessity of curbing trusts and monopolies, and not as germane to the patent system. There is obviously no justification whatever for such discrimination against patents and manufactures under patents as is proposed.

This is not the time or place for a discussion of these provisions in detail, but I urge the members of the American Bar Association to read sections 5, 7, 8, and 9 of the proposed act, so that each member may determine for himself whether there was ever suggested more unreasonable and illogical legislation. Those sections, in phrases which, though in many cases vague, obviously involve the most far-reaching and destructive restrictions, penalize those manufacturing under patents while allowing those who make unpatented articles under the same conditions to be entirely free to do their business without any such restrictions.

These anti-trust provisions in the Oldfield Bill were taken almost bodily from the so-called Lenroot Bill, which was of general application and which the Judiciary Committee of the House of Representatives after full hearing did not report. It seems incredible that they can ever become law, whether general in their application or confined to the field of patented manufacture.

The remainder of the Oldfield Bill is significant by reason of its attack on certain fundamental principles of the United States patent law to which I have already referred. The American patent law from the beginning

has applied definitely and radically the provision of the federal constitution that for the purpose of promoting the useful arts and as an inducement to inventive effort there shall be granted to him who makes a patentable invention the "*exclusive*" right to make, use and sell the same for a relatively short period. Under the constitution, the statutes and the decisions of the courts he who turns his attention to inventing has always known that if he succeeded in securing a patent his right, during the term of the patent, to deal with the invention as he chose was absolute. He or his successor in title could use it or not. He could license others to use it or refrain from so doing. He could sell the whole or a part, or make any contracts "not definitely unlawful" with relation to it. In his efforts, or in the efforts of his assignees or licensees, to build up a market for the invention he, or they, had a free field for the exercise of ingenuity in determining how to handle the patent properly in such a way as to get from it adequate returns. The patentee could offer to capital the same monopoly that he had himself. He was entirely free to make practically any contract or any series of contracts "not in their very nature illegal" which he chose. Having given to the world a new thing, he could impose, during the short term of the patent, any conditions which seemed to him to his advantage that are not inconsistent with restrictions imposed in the exercise of the police power or in violation of underlying and fundamental principles of law. There is no question that this legal situation has resulted greatly to the public good.

The inventor or the investor backing him, knowing that if success were attained the patent owner would have a free hand for seventeen years, from the beginning of our history as a nation has been ready to take great chances by way of effort and expenditure of money although he knew that many inventions fail and that a substantial part of them are of commercial value only in the later years of the term of the patent.

Any provision in the law preventing the imposition of conditions, as part of a sale or license of a patented article or of a contract authorizing its manufacture or use, or any requirement that would impose a penalty if the invention was not manufactured, and particularly any requirement by which under any circumstances a license to use the invention could have been acquired without the patent owner's consent, by a person or corporation to whom the patent owner did not wish to grant a license, would undoubtedly have checked invention and the development of inventions to a marked degree. The testimony before the Oldfield Committee of those familiar with the subject is practically unanimous on this point.

And yet it is just such an inroad upon the established law of the land that characterizes the Oldfield Bill, not only in the anti-trust provisions already referred to, but in its remaining sections. It provides for a compulsory license in certain contingencies and for a limitation upon the right to impose conditions, such as are now lawful, in the disposition of a patented product. The specific provisions of the bill on these subjects may not seem very drastic; they may not be very effective; but they would, if they became law, undoubtedly operate to discourage invention to a marked degree. And a most serious consideration is that there would be an attack upon a basic and most important principle of our patent law which opens the door to further like attack. It is at the beginning of such a crusade that the matter should be carefully considered and if such a change in the law is unwise, all possible effort made to prevent it. I urge every member of the American Bar Association to study the Oldfield Bill and, if possible, to read the testimony before the Oldfield Committee. If, after full consideration, the members of the Association conclude that the bill in whole and in part is thoroughly bad, in that it would operate to discourage invention at a time when it needs most to be encouraged, and is an entering wedge for further destructive legislation, they can perform a public service by opposing it. I only call attention to the fact that a very large number of our business enterprises have been established and their methods developed, relying upon the law as it stands. Whether it is for the public interest that these enterprises should be demoralized by such a modification in the law as is proposed, or whether expediency or good faith permit such change, are questions not within the scope of this paper.

I believe that there is but little occasion for the revision of our patent laws in so far as fundamental principles or the provisions of the statute are concerned. The substantive law seems altogether admirable. It is far otherwise with the procedure of the courts and Patent Office. The entire practice in patent cases in the courts up to the recent rules formulated by the Supreme Court of the United States was vicious and defective to the last degree. It is doubtful if it will be satisfactory under the new rules.

Reform in the procedure in patent cases is a legitimate field for effort. The methods of the Patent Office, particularly in interference cases, need thorough revision. All such changes can be easily brought about if only sufficient and definite attention is given to the subject.

Under the present system of nine Circuit Courts of Appeal there is serious confusion in the application of the patent law to special cases, resulting in some instances in a divergence of views between two different Courts of Appeal as to the validity and scope of the same patent, and generally in the different circuits in a want of harmony as to questions of patentability, construction of patents and infringement, that is a serious evil. The establishment of a single Court of Appeals in Patent Causes, for which the American Bar Association has worked so assiduously for more than ten years, will correct these evils. Although there is no valid argument against such a Patent Court of Appeals and no real criticism upon the American Bar Association's bill providing for its establishment, Congress has as yet failed to act. This most important of all reforms in patent matters is sure to come, and the more vigorously the members of the American Bar Association press for it, the sooner will the law be passed.

I have said nothing in this paper as to the sense and justice of a full recognition of intellectual property as a real thing, or as to the clear right of such property to protection on scientific, logical and ethical grounds. I have endeavored to approach the subject matter entirely from the point of view of the interest of the community as a whole, which, in my opinion, requires for its prosperity an adequate patent system. I believe that ours is adequate, that in its substance it is not open to serious criticism and that it would be a national misfortune if it were weakened as proposed by the Oldfield Bill.

I have only touched upon many most important phases of the situation which would require complete discussion if the question under consideration were whether or not our patent law should be amended on the lines of the Oldfield Bill or otherwise. For example, I have not undertaken to advance the many reasons why compulsory licenses would surely be arbitrary, unfair and utterly ineffective for the purpose intended. I have not dealt, except incidentally, with the allegation which is sometimes made that any patent system, and that of the United States in particular, promotes monopoly to an offensive extent. I have made no reference to such charges as that inventions are "suppressed" and patents "pigeonholed," a proposition which, as a substantial matter, has never been and cannot be supported by any evidence. The testimony before the Patent Committee of the House of Representatives, to which reference has already been made, deals with these and many like questions. My single purpose in this paper is to emphasize the controlling importance of a liberal patent system, to point out that at the present time it is more essential than ever to our national well-being, and to express my belief that no fundamental changes in our law are now desirable. Particularly, there should be, in my opinion, no change in the direction foreshadowed by the Oldfield Bill.

The Aroma of Coffee

The tonic and stimulating properties of coffee have been known for a long time. Learned men attribute all the virtues of this precious produce to caffeine. But M. Gabriel Bertrand of the Pasteur Institute, after a certain number of researches undertaken in collaboration with M. Weisweiller, has just discovered that an infusion of coffee owes its aroma, not only to caffeine, which has been studied for a long time past, but also to the presence of a volatile alkaloid recognized by chemists as being *pyridine*, the smell of which, however, in the mass, is disagreeable. It is probable that the infusion of coffee owes a part of its physiological action to pyridine, of which it contains a proportion corresponding to a quarter of a gramme per kilogramme of coffee.

M. Gabriel Bertrand has observed that by adding caffeine to boiling sugared water, the aroma of coffee is obtained, but if to this decoction some pyridine is added, in a proportion equal to that which is normally contained in coffee, the aroma of the coffee immediately becomes much stronger. It would seem then that traces of pyridine increase the aroma of coffee.

Different varieties of coffee contain variable proportions of pyridine. The quantity of pyridine contained in a kilogramme of coffee varies from 200 milligrammes to 250 milligrammes.—*The Chemical News.*

Women Students at German Universities

The unusual increase in the number of women attending German universities, as shown by statistical returns recently issued in Germany, is of particular interest in view of the fact that women were only admitted as students in the summer of 1905. A note in the issue for July 4th of the *Journal of the Royal Society of Arts* states that during 1912 the number of women students in German universities has grown from 2,795 to 3,213, and the percentage of women now in the universities, as compared with the whole student body, is 5.4 per cent, as against 2.7 per cent three years ago. Of the present body of women students the great majority, 2,900, come from Germany. Of the foreign women, Russia furnishes more than a third, America about a fourth, and other European countries most of the others. Few women students come from Asia, Africa, or Australia. The University of Berlin alone has more than one fourth of the total women students of the Empire, the exact number of women in the large universities at present being: Berlin, 904; Bonn, 289; Munich, 262; Göttingen, 237; Heidelberg, 219; Freiburg, 189; Münster, 172; Breslau, 150; Leipzig, 129; Marburg, 126; Königsberg, 107; Greifswald, 83; Halle, 81; Jena, 65; Strassburg, 52; Kiel, 40; Tübingen, 38; Giessen, 24; Erlangen, 21; Würzburg, 16; Rostock, 6; all others, 3. The departments of study to which the women students give preference are about the same as in former years, the enrollment in certain courses being: Medicine, 702; mathematics and natural sciences, 579; economics and agriculture, 91; dentistry, 17; and pharmacy, 8.—*Nature.*

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Table of Contents

918

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shes
ther
men
The
h of
um-
ing:
237;
lau,
107;
52;
21;
art-
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3.00
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arti-
and
ught
d.

PAGE
210
211
212
214
217
217
218
219
219
219
220
221
221
221
222
224
224